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Capital investment analysis in the Navy

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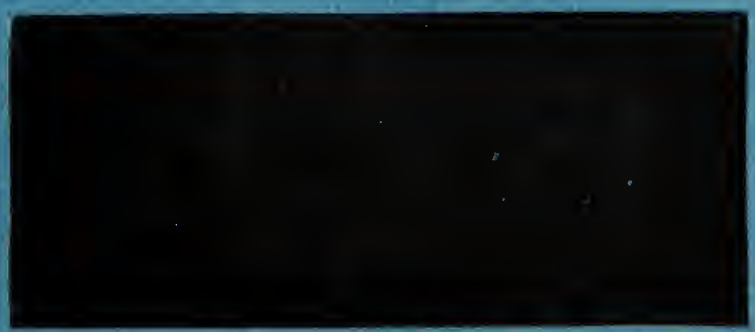

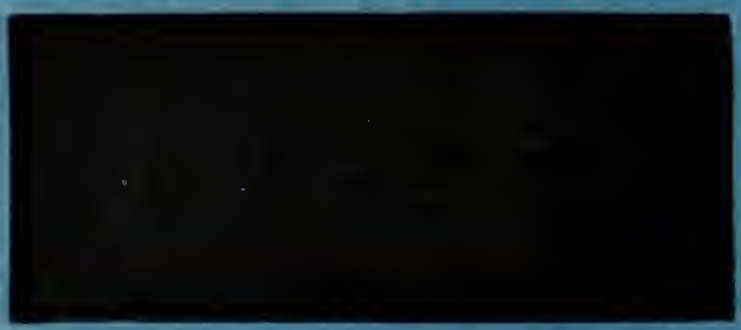

CAPITAL INVESTMENT ANALYSIS IN THE NAVY

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INTRODUCTION

"Analysis is no substitute for sound intuitive judgment, but neither is such judgment a substitute for analysis."[1] Perhaps no other statement could summarize as well the need for a coalition of analysis and experience in the capital investment decision-making process. In turn, probably no other area of decision making is as important to the success of the firm as is capital investment.[2]

Conceding the importance of capital investment to the private sector of the economy, is the capital investment decision any less important to the public or governmental sector? The magnitude alone of the value of investment decisions already made in the public sector would indicate the importance of these decisions. Further, there is no indication of a contraction of governmental activity so that the importance of investment decisions, as measured by volume, is unlikely to diminish.

The Navy can be considered to be composed of nine organizational entities (including the Marine Corps) with certain associated acquisition

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[1] A. J. Merrett and Allen Sykes, The Finance and Analysis of Capital Projects (New York: Wiley and Sons, Inc., 1962), p. 178.

[2] Robert W. Johnson, Financial Management (Boston: Allyn and Bacon, Inc., 1962), p. 174.

costs and replacement costs of the existing assets. Table 1 illustrates the magnitude of the capital investment in the Navy.

TABLE 1

MAGNITUDE OF CAPITAL INVESTMENT IN THE NAVY

Organizational Entity	No. of Activities	Acquisition Cost	Replacement Cost
Naval Air Systems Command	64	$4,087,990,000	$ 8,609,361,000
Naval Ordnance Systems Command	50	986,425,000	2,398,160,000
Naval Supply Systems Command	117	553,261,000	1,424,326,000
Naval Ships Systems Command	64	1,397,934,000	4,273,480,000
Naval Electronics System Command	27	35,205,000	47,917,000
Bureau of Naval Personnel	99	50,554,000	929,854,000
Naval Facilities Engineering Command	40	883,826,000	1,871,174,000
Bureau of Medicine and Surgery	69	218,018,000	521,373,000
Marine Corps	44	657,197,000	1,334,496,000
	574	$8,870,410,000	$21,410,141,000

Source: Current Naval Facilities Engineering Command briefing charts.

The majority of facilities constructed have been financed by projects that were included in the Navy Military Construction Program through

the years. A history of the volume of Military Construction dollars from 1949 to the present time is shown in Fig. 1.

Points of interest in Fig. 1 are as follows:

A = Construction peak in support of the Korean War.

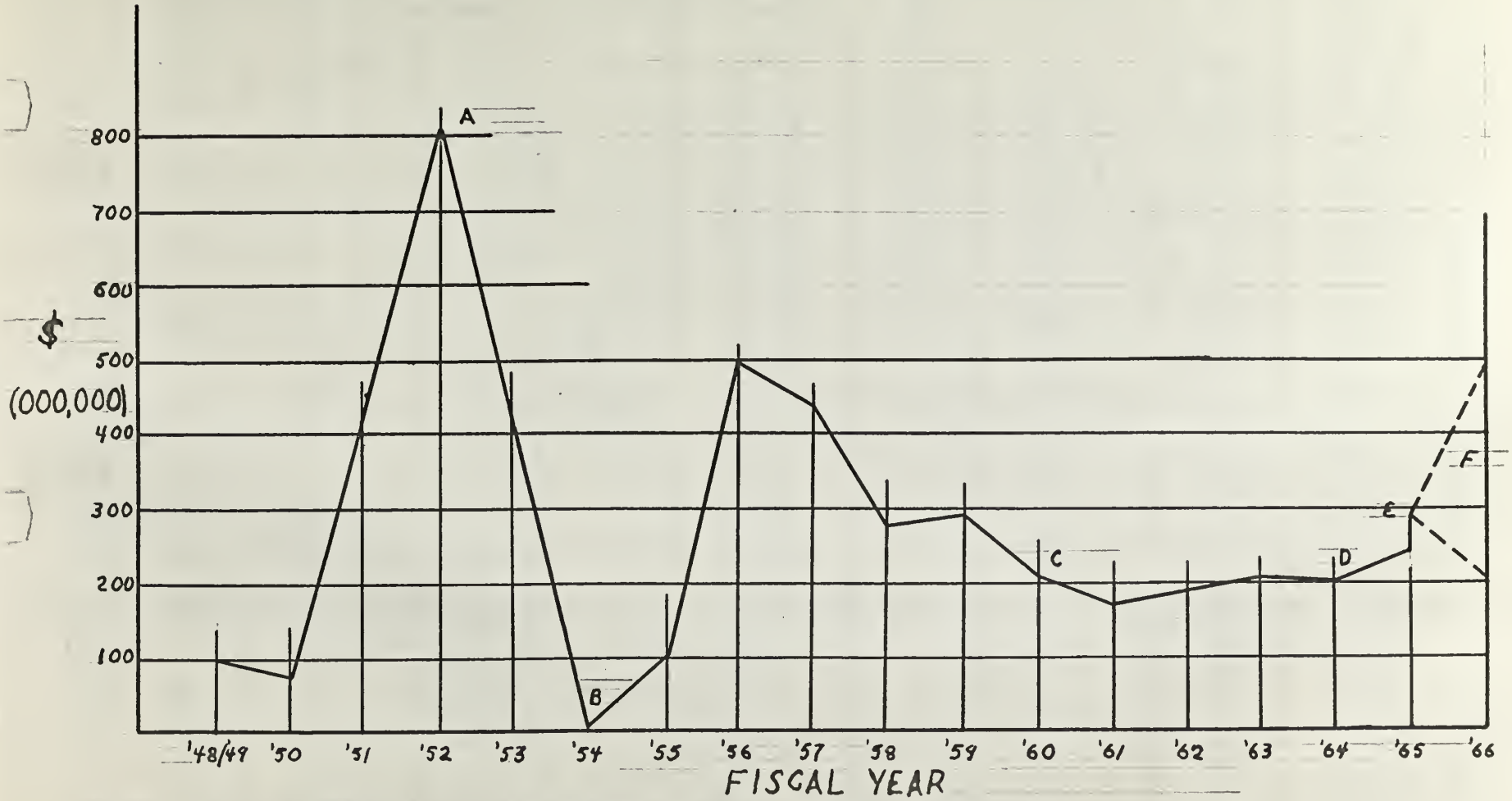
B = Fiscal Year 1954--no construction funds approved.

C-D = The years 1960 to 1964 when a "level funding" concept was in effect.

E = The beginning of the Vietnam buildup; $22 million in supplemental funds added to a base of $250 million.

F = From this point forward, no accurate portrayal of the Military Construction Program is feasible.

Conceding, then, the importance of investment decisions within the government, it is now proper to ask whether or not there is any commonality between methods of analysis which might be applied by both the private and public sectors. After all, the success of the capital investment decision made by a corporation may be rather precisely measured, whereas there is often an element of doubt that surrounds capital investment decisions made by a governmental agency. The "mere" facts that we may eventually reach the moon or succeed in installing peace in Vietnam will not by themselves show that the investment decisions associated with those two events were correct, or that they were even the best of all possible alternatives.



Source: Current Naval Facilities Engineering Command, Briefing Charts.

Fig. 1. --Navy Military Construction Program, 1948 to Present

The Research Questions

The basic research question to be answered by this thesis may be stated as follows: Are the theoretical techniques of capital investment analysis, which have been developed for use by the private sector of the economy, applicable to the analysis of capital investment projects in the Navy? Subsidiary to the central research question are a number of related questions, as follows:

1. What are the techniques of capital investment analysis?
2. What techniques of capital investment analysis have been implemented in the Navy?
3. Should capital investment projects in the Navy be required to show a return? If so, how much of a return?
4. What is the best way to handle risk or uncertainty allowances in the analysis of capital investment projects in the Navy?

Limitations

The breadth of possibility for investigation suggested by the title, "Capital Investment Analysis in the Navy," is quite overwhelming. In arriving at the exact area for thesis exploration, a number of limitations must be imposed in order that a paper can be developed in sufficient depth. The first limitation confines the investigation to the Military Construction Program. Although capital investment analysis also properly includes the acquisition of equipment and machinery, inclusion of the Navy procurement programs in the paper would result in unmanageable scope.

The second limitation restricts the main thrust of the paper to the so-called "economic project." Within each year's Military Construction Program, there exists a small number of projects which, if implemented, promise to more than repay the capitalization costs with firm, quantifiable savings. Since this class of projects is directly comparable to profit-making projects within the private sector, the main emphasis will be in this area. Non-economic projects within the Military Construction Program will be touched on, but since by definition they lend themselves to rigorous analysis only as long as they are mutually exclusive, they are not emphasized.

The third limitation involves the development of a comprehensive system of investment analysis within the Navy. Investment analysis may be thought of as being both a specific technique of ranking the attractiveness of various proposals and an entire decision-making sequence which leads to the final action to accept or reject a proposal for actual financing. There are some schools of thought that consider the last to be the most important part of investment analysis, as indeed it may well be.[1] The development of an entire decision-making sequence for the Navy, after giving due attention to the specific techniques of investment analysis, is beyond the scope of this paper. In fact, although of some academic interest, the development of such a sequence would have little practical value since the Navy does not make final financing decisions for its capital investments. Capital investment recommendations by the Navy are subject first to further

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[1] Ross G. Walker, "The Judgment Factor in Investment Decisions," Harvard Business Review, XXXIX, No. 2 (March-April, 1961), 93-99.

[illegible]

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[1] [illegible]

recommendations by the Department of Defense and finally to approval by the Congress. The development of a single viable system, incorporating pertinent aspects of the economic and political considerations, is a highly improbable goal.

The fourth limitation involves the cost of capital section of the investigation into the theory of capital investment. Some notion of a firm's cost of capital must be known when applying techniques of investment analysis, yet the cost of capital topic by itself is controversial and a complete treatment of this single item would be of at least thesis scope by itself. This paper will deal with the cost of capital, but only in sufficient detail to place it in its proper perspective.

Organization of This Paper

Chapter II is designed to present the theory of capital investment analysis as viewed by a number of contemporary writers and educators. Research into a number of publications has revealed that there is far from complete agreement on the best way to proceed from a theoretical viewpoint, and there is some indication that there is even less agreement in the application of the theory. As an example of the application difficulties, a recent conference of businessmen failed to reach agreement on what the proper rate of return was on a common investment problem. The results varied by as much as 300 per cent.[1] Before proceeding with an analysis of the

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[1] Ibid., p. 96.

Navy's investment problems, then, some common ground of understanding of the elements of capital investment analysis is necessary. Chapter II examines various methods of analysis, gives a detailed comparison of the net present value method versus the internal yield method, looks at the cost of capital implications and the various methods of classifying projects, and, finally, deals with perhaps the most important of all elements of capital investment, the element of risk or uncertainty.

Chapter III presents the Department of Defense approach to capital investment analysis, as promulgated in its recent Interim Operating Procedure No. 6--Economic Analysis of Proposed Defense Investments. An interplay of this chapter with Chapter II will demonstrate some of the weaknesses as well as strengths of the Defense Department's approach to the problem. Since the Navy must work within the framework of Defense Department procedures, the importance of Chapter III is obvious.

Chapter IV presents a recommended approach to capital investment analysis in the Navy. Briefly stated, the recommended approach will embody the strengths of the Defense Department method, reinforced with applicable portions of the findings in Chapter II. In other than an academic setting, the futility of Chapter IV is immediately apparent. Regardless of any superiority of approach to the problem which the Navy or any of the other services might develop, the fact remains that the project submissions to the Department of Defense must be in the format dictated by it.

Chapter V is a two-part application of theory to an actual project. In the first part, the project is analyzed in accordance with Defense criteria. In the second part, the project is analyzed in accordance with the criteria developed in Chapter IV. The project selected is one which was submitted to Defense by the Navy for inclusion in the Fiscal Year 1968 Military Construction Program and subsequently disapproved by Defense. Although it was not presented as an "economic" project, the indications are that it will qualify as an economic project.

Chapter VI is a summation of the findings and conclusions of the paper.

Methodology

Different research techniques or methodology are required to develop the necessary data which form the basis for each of the succeeding chapters. Chapter II is based entirely on library research into the vast volume of books and technical articles that have been written about the subject of capital budgeting or investment analysis.

Chapter III is based mainly on a Department of Defense directive, Interim Operating Procedure No. 6--Economic Analysis of Proposed Defense Investments. Interviews with key Department of Defense officials who helped develop the procedures set forth in Op-6 will be used to round out the research of Chapter III. Chapter IV is based on the research which has been conducted in support of Chapters II and III.

Chapter V is based on data which have been requested from the Naval Facilities Engineering Command field activities. It was decided that better response would be assured if the needed information were requested by Nav Fac rather than by an individual researcher. Consequently, areas of common interest were found between the requirements of the thesis and the functional requirements of Nav Fac. The required information was then requested through official channels. Appendix III displays the requesting letter and the response thereto. The project analysis is done in accordance with Chapters III and IV.

CHAPTER II

THE THEORY OF CAPITAL INVESTMENT ANALYSIS

General

Simply stated, capital budgeting may be viewed as the planning of expenditures whose returns will be realized beyond a one-year time interval.[1] The problem may be viewed as having three distinct parts: the determination of how much money will be needed; the determination of how much money will be available; and the determination of how the available funds should be doled out among the candidate projects.[2]

Capital investment analysis forms a major segment of the whole capital budgeting procedure for any organization. It is through the organization's investment analysis procedures that the available investment proposals are presented to the decision makers and ranked in some order of attractiveness, for inclusion in the capital budget. If the capital investment analysis procedures are theoretically sound, then sound investment decisions can be expected. The heart of the problem rests with the selection of consistent, theoretically correct analytical procedures.

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[1] J. Fred Weston and Eugene F. Brigham, Managerial Finance (New York: Holt, Rinehart and Winston, Inc., 1963), p. 118.

[2] Joel Dean, Managerial Economics (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1951), p. 555.

Before any analysis of a proposed capital investment can proceed, a certain amount of data must be generated and arranged in a logical pattern. The estimated costs of the proposal, including non-capitalized costs germane to the investment, and net increases in working capital form the project cash outflows. The cash inflows consist of the earnings estimated as a result of the project implementation, net of depreciation tax effects, and include any residual values attributable to the project.[1]

The next step is to construct a cash flow chart which shows the estimated cash inflows and outflows in the year in which they are expected to occur. This much of the theory of capital investment analysis is generally agreed upon. What is done with the figures from this point forward is controversial.

Through the years, a number of methods for analyzing capital investment decisions have been developed. They range in complexity from the simple payback analysis to the more sophisticated discounted cash flow methods. Many of these methods are merely different names for an identical or similar technique found elsewhere in the literature. There seem to be six methods that appear more frequently than any of the rest, and these six will be described.

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[1] Robert N. Anthony, Management Accounting (Homewood, Ill.: Richard D. Irwin, Inc., 1964), pp. 628-630.

Methods of Analysis

The payback method. --The payback method is a simple expression of the period of time estimated to recover the investment cost of the project through the incremental cash flows attributable to the project. The payback period of a project is of some use as a rather coarse screening device, particularly in those situations where liquidity versus profitability is a dominant short-run consideration.[1] The critical shortcoming of the payback method is its failure to consider cash flows after the period of recovery of and above the dollar value of the investment. For this reason it is not a measure of the profitability of a potential investment and should seldom be used to choose between several projects.

Proceeds per dollar of outlay. --Unlike the payback method, this method provides some attempt at measuring profitability. As the name implies, the method involves taking a ratio of the total net estimated proceeds of the project to the dollar outlay of the project. Because of this method's failure to consider the time value of the proceeds, treating a dollar earned ten years hence as having the same value as a dollar earned next year, it has limited use as a valid means of ranking several projects.

Average annual proceeds per dollar of outlay. --This method takes the ratio of the annual average of the net returns of the project to the cost of the project. There is no consideration given to the duration of the project

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[1] Ezra Solomon, The Theory of Financial Management (New York: The University Press, 1963), p. 123.

and in this regard it is similar to the payback method. This method also is a poor way to discriminate between projects.

Average income on the book value of the investment. --This method has its roots in the "return on investment" concept which is sometimes used to measure a firm's efficiency in the gross employment of its capital. Application of the same principle to an individual project will provide some measure of the expected performance of that project. The method involves a ratio, the numerator of which is the average proceeds of the project, less the average depreciation. The denominator is the average book value of the project, over its estimated life. The method has some value in considering the worth of a single project, but it fails to consider the time value of the proceeds and therefore is of little help in ranking a number of projects.[1]

The yield method. --The yield method and the one to follow, the present value method, belong to the financial technique called "discounted cash flow." Of central importance to both methods is the common discount formula:

$$C = \sum_{i=1}^{i=n} \frac{A_i}{(1+r)^i}$$

Where: C = the investment cost.
Ai = the net proceeds for each succeeding year
r = the discount rate
i = year 1, year 2, . . . year n.

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[1]Harold Bierman, Jr., and Seymour Smidt, The Capital Budgeting Decision (New York: The Macmillan Company, 1964), pp. 21-22.

In the application of the yield method, the discount formula is solved for r. In application of the present value method, some value for r is assumed and C is computed. The computed value of C is not the investment cost, as is the case with the yield method, but is, rather, an expression of the "present value" of all the estimated proceeds of the project. If the present value of the proceeds exceeds the estimated investment cost, then the project is valuable since the value of the cash flows, discounted at the required rate, exceeds the estimated cost. So it is seen that while the yield method and the present value method both involve the same data and the same equation, the philosophy of application is quite different. A detailed comparison of the differences will follow in a later section of this chapter.

The solution of the discount formula for the rate of discount is usually done by trial and error: by a process of computing the present value assuming different discount rates until that rate is found which will make the present value equal to the investment cost. An alternate procedure would be to compute present value several times, using different discount rates, then construct a chart of discount rate versus present value and obtain the yield of the project in this fashion.[1]

Whatever the individual technique used to solve for the discount rate, the end product of the yield method is a rate of return for that project which is directly comparable to the cost of capital used in the construction of the

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[1] Ray I. Reul, "Profitability Index for Investments," Harvard Business Review, XXXV, No. 4 (July-August, 1957), pp. 116-132.

project. In theory, the yield method is technically correct and can be used to rank projects and to make "go" or "no go" decisions concerning projects.

The present value method. --By first assuming the cost of capital, the cash outflows and the cash inflows of a project can both be discounted to the present time and compared. If the present value indicates a net positive value, then the project is worthwhile. If the net present value is negative, then the project will not repay the cost of capital necessary to construct the project. The size of the net present value is an indication of the relative worth of mutually exclusive projects, while a ratio called the profitability index can be used to rank either mutually exclusive projects or so-called competing projects. The profitability index is obtained by dividing the present value of the cash inflows by the present value of the cash outflows.[1]

Among the various procedures for evaluating proposals for capital expenditures, only two are theoretically correct: the yield method and the present value method. If identical assumptions are made, the two methods should always produce identical results.[2] Implementation of theory is quite another matter, however, and in industry today it is seldom that any two methods in use would yield consistently comparable results.[3]

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[1] Anthony, op. cit., p. 637.

[2] Robert W. Johnson, Financial Management (Boston: Allyn & Bacon, Inc., 1962), p. 176.

[3] Reul, op. cit., p. 117.

As an illustration of how the methods discussed would rank hypothetical alternatives, consider the investment proposals shown in Table 2.

TABLE 2

HYPOTHETICAL INVESTMENT ALTERNATIVES

Investment	Initial Cost	Net Cash Proceeds per Year		
		Year 1	Year 2	Year 3
A	$10,000	$10,000	$ -0-	$ -0-
B	10,000	5,000	5,000	5,000
C	10,000	2,000	4,000	12,000
D	10,000	10,000	3,000	3,000
E	10,000	6,000	4,000	5,000
F	10,000	8,000	8,000	2,000

Source: Bierman and Smidt, op. cit., p. 14.

No system is needed to arrive at some basic observations concerning the proposed investments. Investment A returns only the initial cost and is the least attractive, therefore. We would be better off to hold the funds in cash unless there were some consideration other than economic that bears on the problem. Projects B and E both return $15,000 on a $10,000 investment. Since Project E returns $1,000 one year earlier than Project B, we would prefer to invest in this project. Project D returns a total of $16,000, with heavy returns in the first year. Project D then appears better than either B or E. Projects C and F, the remaining two,

both return $18,000, but the patterns of cash inflow are distinctly different. There is no doubt that project F, with its earlier return, is preferable to project C, but what about the relationship of D to F? Depending upon the value of the "locked up" capital, high initial returns may offset eventual lower total returns.

By applying the methods discussed in this section, the rankings of the six investment proposals can be arranged as shown in Table 3. In applying the average-income-on-book-value method, straight line depreciation with no residual value is assumed.

TABLE 3

SUMMARY OF RANKINGS

Method Used	Investments					
	A	B	C	D	E	F
Payback	1	4	6	1	4	3
Proceeds per Dollar of Outlay	6	4	1	3	4	1
Average Annual Proceeds per Dollar of Outlay	1	5	2	4	5	2
Average Income on Book Value of Investment	6	4	1	3	4	1
Yield	6	5	3	2	4	1
Present Value (at 6 per cent)	6	5	2	3	4	1
(at 30 per cent)	6	5	3	2	4	1

Source: Bierman and Smidt, op. cit., p. 31.

Project A, which by inspection was seen to be a poor choice, is ranked first by the payback and average annual proceeds methods. The other methods correctly rank project A last. An interesting observation can be made about projects C and D as rated by the yield and present value methods. At a low discount rate, the $2,000 greater cash return of project C gives that project priority over D, which has higher initial returns, but less total benefit. By raising the required earnings rate to 30 per cent, the more distant but larger returns of project C are handicapped sufficiently so that the project is ranked behind project D.

This concludes a very brief description of some of the methods of capital investment analysis. Due to their failure to consider the time value of money, the first four methods will not be discussed further in the paper. The next section will take a more detailed look at the two acceptable methods, yield and present value.

Present Value Compared to Yield

The first and most obvious difference to be considered in the comparison of present value to yield is the application of the cost of capital or required return rate. It is sometimes considered that one of the advantages of the yield procedure is that it may be utilized without deciding on the cost of capital, while the cost of capital must be incorporated into the present value computation. While this is true to a degree, the fact remains that eventually the cost of capital facing the firm must enter into the decision, regardless of which of the two methods is used. In the yield method, the

yield of the proposed project must be compared to the firm's cost of capital as an evaluation of the worth of the project. Hence, the cost of capital is important to both methods, although it enters at a later stage in the yield method than in the present value method.[1]

Yet, the fact that the yield analysis may go forward without use of the cost of capital is a distinct advantage, although not for the reason cited above. When using present value, the entire calculation rests upon a guess: the cost of capital. If the cost of capital used is wrong, all of the results calculated by the present value method are subject to error. The results calculated by the yield method are unaffected by the cost of capital.[2] The implication of this statement is that projects that are competitive (that is, not mutually exclusive) will always be properly ranked by the yield method, whereas they may not be correctly ranked by the present value method. The reason for the potential misranking of competitive projects by the present value method lies in the fact that the rates of change of present values with respect to the discount rate can be different for each project. Just because project A shows a greater net present value than does project B when a low discount rate is used is no assurance that project A will remain superior to project B for all discount rates. If the rate of change of project A's present value is more sensitive to the discount rate than is project B's, there will

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[1] Bierman and Smidt, op. cit., p. 35.

[2] Johnson, op. cit., p. 192.

exist some discount rate at which the two projects will be equally ranked. A further increase above the equalizing discount rate will mean that project B becomes superior to project A.

It is therefore obvious that the very ranking of competitive projects by the yield method depends upon the discount rate (cost of capital) which is used. When, in the yield method, the inevitable comparison to the cost of capital is made, there may be some errors made in the case of those competitive projects whose yield is very close to the estimated cost of capital, but at least the projects will be considered in the correct order. The special problems inherent in the yield method when analyzing mutually exclusive projects are discussed later in this chapter under Mutually Exclusive versus Competitive Projects.

The Reinvestment Assumption

The assumption inherent in the yield method is that the returned cash will be reinvested at the same rate of return as that implied by the project itself.[1] The assumption inherent in the present value method is that the returned cash will be reinvested at the rate of return that was used to determine the present value.[2]

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[1] Victor H. Brown, "Rate of Return: Some Comments on Its Applicability in Capital Budgeting," Contemporary Issues in Cost Accounting, ed. Hector R. Anton and Peter A. Tirmin (Boston: Houghton Mifflin Company, 1966), p. 420.

[2] Bierman and Smidt, op. cit., p. 39.

To illustrate the import of the reinvestment rate, consider Table 4 which shows projects C and D from the group of six projects used earlier.

TABLE 4

HYPOTHETICAL INVESTMENT ALTERNATIVES

Project	Initial Cost	Net Cash Proceeds per Year		
		Year 1	Year 2	Year 3
C	$10,000	$2,000	$4,000	$12,000
D	10,000	10,000	3,000	3,000

Project C shows a yield of 27 per cent, compared to a yield of 37 per cent for project D; hence, by the yield method, project D is more valuable. The present value method with a 6 per cent discount factor shows project C to be more valuable, but if the discount rate is raised to 30 per cent, D becomes more valuable. The differing results are brought about by the reinvestment assumptions associated with each method.

Fig. 2 is a chart of the two projects, C and D, with the net present values shown in the vertical and the discount rate shown horizontally.[1] The intersection of the locus of the function with the horizontal axis will give the yield of the project since, by definition, yield is that value of discount which will give a zero net present value. It is noted that project C

[1] Carl L. Moore, "The Concept of the P/V Graph Applied to Capital Investment Planning," Contemporary Issues in Cost Accounting, ed. Hector R. Anton and Peter A. Tirmin (Boston: Houghton Mifflin Company, 1966), p. 441.

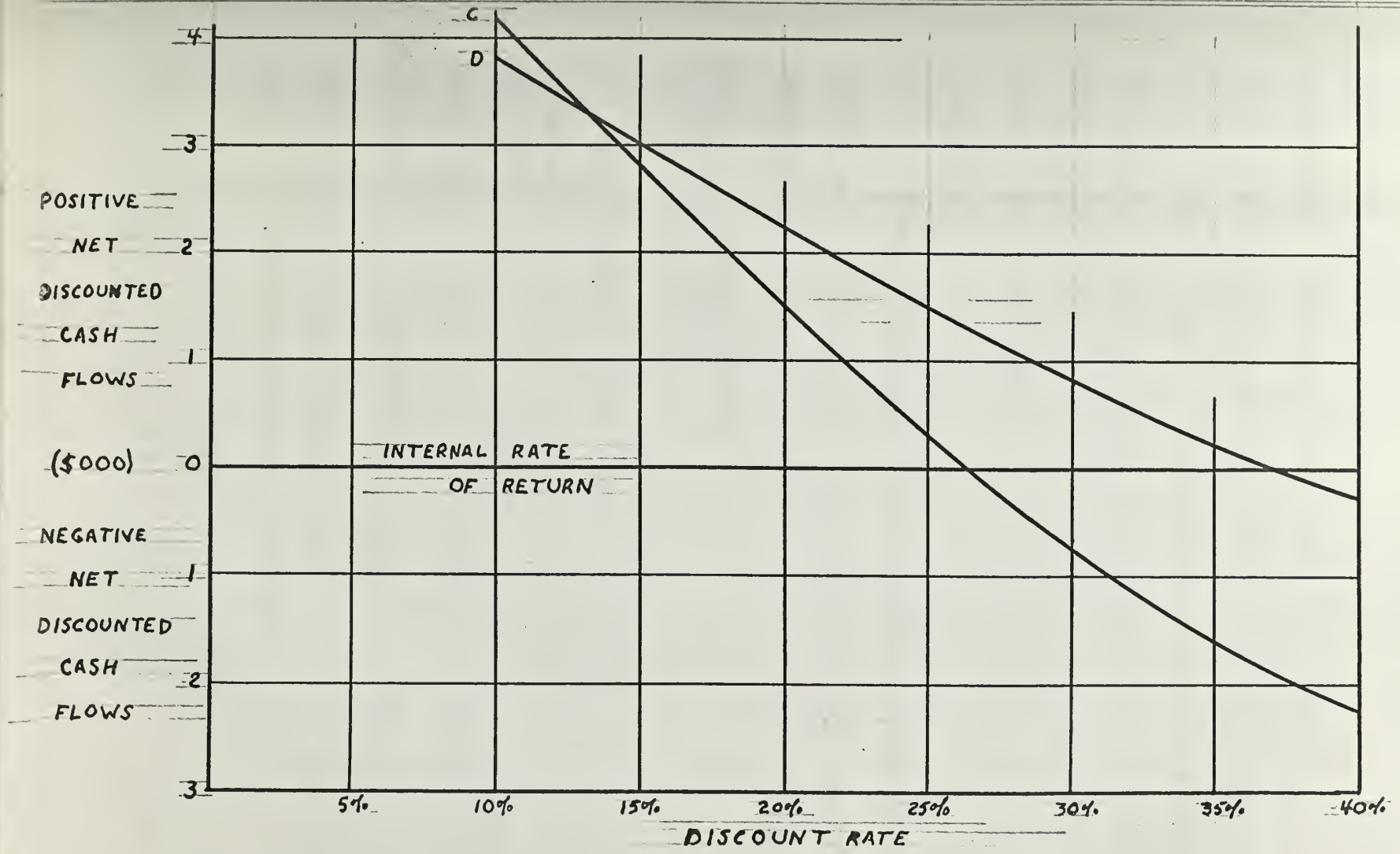

Fig. 2. --Net present value vs. discount rate for two assumed investment projects

intersects the horizontal axis at a discount rate of 27 per cent, while project D intersects the horizontal axis at 37 per cent, which are the respective yields for the two projects. It is further noted that at the lower discount rates, project C has an advantage while project D is preferable at higher discount rates. The point of intersection of the two curves is of great interest, for it is at this common discount rate that the two projects have equal value. The equalizing discount rate for the two projects under consideration is 13 per cent. The importance of this value is illustrated by the following example.

Assume that both projects C and D have been implemented and the cash flows occur as predicted. If the cash throw-offs from the two projects are then reinvested at 13 per cent, the two projects have the same value to the firm, as shown in Table 5.

TABLE 5

EQUALIZING REINVESTMENT RATES FOR TWO PROJECTS

Cash Flow	Project C	Project D
First year	$2,000 x 1.13 = $2,260	$10,000 x 1.13 = $11,300
Second year	$(2,260 + 4,000 x 1.13 = 7,100	$(11,300 + 3,000 x 1.13 = $16,100
Third year	$7,100 + 12,000 = 19,100	$16,100 + 3,000 = $19,100

If the reinvestment rate is higher than 13 per cent, project D is the most valuable. At reinvestment rates less than 13 per cent, project C

becomes the most valuable.

In considering the advantages and disadvantages of the yield method versus the present value method, it is obvious that the reinvestment opportunity must also be considered. Some writers credit the present value method as being the most valid from the point of view of reinvestment rates, contending that the investment rates used in the present value formula will more closely coincide with investment rates available to the firm.[1] From the illustration just given, it is apparent that neither present value nor the yield method gives a wholly lucid picture of the reinvestment situation by itself. If more information is required about reinvestment rates before the original investment decision can be made, then the best approach is to use the graph approach demonstrated.[2]

Multiple Yields and the Infinite Rate Problem

From time to time, those projects occur which will generate a negative cash flow during one or more years of life of the project. If a project costs $10,000 and returns (+) $60,000, (-) $110,000, and (+) $60,000 in the first three years of its life, the return rate or yield of the project is either 0 per cent, 100 per cent, or 200 per cent, because all three of these values satisfy the discount formula.[3] A general rule is that there will be as many solutions to yield as there are sign reversals in the cash flow--three in this case.

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[1] Bierman and Smidt, op. cit., p. 39.

[2] Moore, op. cit., p. 446.

[3] Brown, op. cit., p. 427.

The multiple values of yield mean that between 0 per cent and 100 per cent all net present values will be negative, that they will all be positive between 100 per cent and 200 per cent, and, finally, that they will always be negative above 200 per cent. It is possible to obtain a more meaningful expression of yield by assuming some reinvestment rate. For instance, if a 10 per cent reinvestment rate is assumed, it can be shown that the valid investment rate for the project is 4-1/2 per cent, as follows:

The first year's cash flow of (+) $60,000, compounded for the remaining two years of the project life at 10 per cent, will result in a cash flow of $\$60,000 \times (1.10)^2 = \$72,600$.

The second year's cash flow of (-) $110,000 at 10 per cent for one year will result in a negative cash flow of $\$110,000 \times 1.10 = \$121,000$.

The third year's cash flow of (+) $60,000 is added to the previous (+) $72,600 to give a total positive cash flow of $132,600. The net project cash flows are then $132,600 - $121,000, or $11,600. Since the cash flow has resulted from the original $10,000 investment, the valid return on that investment (having assumed the 10 per cent reinvestment rate) is 4.5 per cent, since $\$11,600 = \$10,000 \times (1+.045)^3$.[1]

It is obvious, however, that with a 10 per cent reinvestment opportunity, the original $10,000 investment should have been made in this area rather than in the illustrated project. The fact remains that even so-called multiple yield value projects can be assigned some valid yield rating, if only a reinvestment rate is assumed.

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[1] Ibid.

The infinite rate problem arises when a project has no immediate cash outlay requirements, yet results in positive cash flows in the first year. Of course, with an initial investment of zero dollars, any return must indicate an infinite yield. The present value method circumvents this problem by discounting all cash flows, positive and negative, to the present time. A valid yield figure can be obtained in this case, however, by discounting the cash outlays back at the cost of capital rate and then using this present value of the investment cost as the basis for the yield computation.

In the multiple yield and infinite rate problem, although use of the present value method appears to circumvent some difficulty, the yield method can be used by modifying the regular procedures. Fortunately, in real life situations, both types of problems are rather infrequent.[1]

Mutually Exclusive versus Competing Projects

It is generally conceded that both the present value and the yield methods of investment analysis will give correct "go" or "no go" decisions, but the ranking of alternative projects is quite another matter. Various authors disagree on which is the more valid method. For example, Professors Bierman and Smidt say:

> When the two methods lead to different decisions, the present value method tends to give better decisions.[2]

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[1] Bierman and Smidt, op. cit., p. 5.

[2] Ibid., p. 34.

Merrett and Sykes, on the other hand, say:

> The incremental yield approach as a method of discriminating between alternatives will generally be found to be the most satisfying method of solution. [1]

Still another technique may be found in the writings of Dr. Anthony, where he states that:

> In order to compare two proposals, we must relate the size of the earnings to the amount of money that is risked. This is done simply by dividing the present value earnings by the amount of investment, to give a ratio that is called the profitability index. The preference rule is as follows: the higher the index number, the better the project. [2]

In order to look at these three statements more closely, consider Table 6, which shows another investment proposal.

TABLE 6

HYPOTHETICAL INVESTMENT ALTERNATIVES, UNEQUAL COSTS

Project	Initial Cost	Annual Cash Income	Life	Yield	Net Present Value (8%)*	Profitability Index
A	$502,000	$100,000	10 yrs	15%	$169,000	1.33
B	$780,000	$144,000	10 yrs	13%	$185,000	1.24
(B-A)	$278,000	$ 44,000	10 yrs	9.6%	16,000	1.06

* - Net present values are shown. The Gross Present Value may be found by taking the sum of the NPV and the investment cost.

Source: Merrett and Sykes, op. cit., p. 154.

[1] Merrett and Sykes, op. cit., p. 154.

[2] Anthony, op. cit., p. 637.

Assume first that the projects A and B are mutually exclusive; that is, selection of one eliminates the other on a physical basis. When only one can be chosen, which will it be? Following the unmodified yield method, project A would be chosen. Following Dr. Anthony's profitability index method, project A would also be chosen. The present value method would select project B.

The direct application of the yield method is not valid in this mutually exclusive case because of the unequal investment costs. To obtain direct comparability of the projects, the yield of the differences must be found.[1] The difference in cost of the projects (B-A) yields a return of 9.6 per cent, and since this return is higher than the cost of capital of 8 per cent, the higher cost project B should be selected over project A. This modification of the yield method should give the same results as the present value method, and indeed it does. In a mutually exclusive situation, then, project B should be chosen over project A.[2] The profitability index has failed to account for the analysis of the differences in this mutually exclusive case and would have picked the wrong project.

If the two projects are now cast in the role of competing or non-mutually exclusive, the yield method and the profitability index would both select project B. In the case of competing projects, the non-comparability of unequal investments by the yield method is no longer valid.[3] From a

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[1] Brown, op. cit., p. 425.

[2] Ibid., p. 426.

[3] Ibid., p. 425.

conceptual basis, the present value method choice, project B, is not correct because it assumes reinvestment of the cash flows at 8 per cent. Project A is also available and offers 15 per cent as a reinvestment opportunity, thus invalidating the present value method in this case. Selection and implementation of project A would allow later implementation of project B, thus insuring that the yield method implication of reinvestment at 15 per cent (in this case) is more valid than the present value method implication of reinvestment at 8 per cent.

Conclusions on Present Value versus Yield Methods

Both methods have strengths and weaknesses, as shown. There is absolutely no reason why capital investment analysis procedures cannot be developed which embody the strong points of both methods. There is no reason why a firm must adopt one method to the exclusion of the other. The Babcock and Wilcox Company has, in effect, combined the two methods to some extent, when they bring future and past costs of an investment to the present time by use of a discount rate, but then compute the yield of the returns against the present value of the investment costs.[1]

There are difficulties in using the yield method in complex, mutually exclusive situations. Since these situations are most likely to occur at the departmental level of the organization, it would be more logical

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[1] "Capital Appropriations System Manual," unpublished manual prepared by the Babcock and Wilcox Company, June 1959, Appendix 2.

if departments screened their projects by use of the simpler present value method.[1] Once the best of the alternatives are sent forward for final selection and thereby become competing projects, there is justification for using the yield method for final selection.[2]

The Cost of Capital

No method of capital investment analysis is possible without some notion of what the firm's cost of capital is. The importance of knowing exactly what the cost of capital is, is subject to some controversy. Some writers feel that an extremely accurate picture of the cost of capital is not needed for investment decision making,[3] while others feel that:

> . . . until it is filled (the correct conceptual approach to measuring the cost of capital), Capital Budgeting theory will remain, at best, only a partial guide to decision making in this important area of business activity.[4]

It is generally conceded that a firm's cost of capital will lie somewhere between what is to the firm low-cost/high-risk debt capital and high-cost/low-risk equity capital.[5] Since the proportion of debt to equity will influence the cost of both factors, it is also generally conceded that there is, or

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[1]Johnson, op. cit., p. 176. [2]Ibid., p. 192.

[3]John F. Childs, "Profit Goals for Management," Management Control System, ed. Robert N. Anthony, John Dearden, and Richard F. Vancil (Homewood, Ill.: Richard D. Irwin, Inc., 1965), p. 486.

[4]Ezra Solomon, "Measuring a Company's Cost of Capital," Readings in Finance, ed. Harold A. Wolf and Lee Richardson (New York: Meredith Publishing Co., 1966), p. 130.

[5]Childs, op. cit., p. 490.

should be, a least cost mix of debt and equity capital in the capital structure of the firm.[1]

While some writers would be content to compute a cost of capital by taking weighted average of the cost of all factors in the capital structure, there is that school which would go further. One of the more elaborate theories holds that the capital investment projects should be compared to a cost of capital which would prevail if the project were not implemented.[2] In other words, a project which promises 12 per cent return should not be accepted if the firm's cost of capital would rise from 10 per cent to 13 per cent without the project, during the life of the project.

A slight variation on this theme is proposed by Modigliani and Miller when they state:

> Will the project, as financed, raise the market value of the firm's shares? If so, it is worth undertaking; if not, its return is less than the marginal cost of capital to the firm.[3]

The theoretical discussion of the cost of capital will not proceed further in this paper. It is sufficient for the purposes of the paper to state that some notion of the cost of capital must be known for capital investment analysis, that the means of computing that cost of capital are not well agreed upon, and that for most practical purposes, a weighted average of

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[1]Ernest W. Walker, Essentials of Financial Management (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1965), p. 61.

[2]Solomon, "Measuring a Company's Cost of Capital," op. cit., p. 134.

[3]Franco Modigliani and Merton H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," Readings in Finance, ed. Harold A. Wolf and Lee Richardson (New York: Meredith Publishing Co., 1966), p. 94.

the cost of the various elements in the capital makeup of the firm is sufficiently accurate.

Risk

> Adjustments to allow for uncertainty may be challenged as nothing more than guesses. Perhaps they are. But even so, they are guesses that must be made, and will be made, either explicitly or implicitly. Failure to apply the probability adjustments does not enable management to avoid the problem; it merely transfers the guess element in disguised form to some other stage of the decision-making process. [1]

The inclusion of risk in the capital investment decision-making process is difficult, but necessary. It is difficult because risk is difficult to quantify; necessary, because investment analysis is largely based on quantification of input factors. Risk, defined, would mean different things to different people. Perhaps the reason for this is the number of types of risk which it is possible to list. A sample of the different types of risk which may be considered follows:

1. Risk from undertaking insufficient numbers of similar investments. The organization may have very limited experience with the type of project being considered, hence the estimates of expected benefits may not be sufficiently based on experience.

2. Risk from misinterpretation of data.

3. Risk of bias. Always present because methods of estimating the future are not susceptible to exact objective verification.

4. Risk from external change. Unforeseen changes external to the system being considered may affect estimates within the system.

5 Risk from errors of analysis. Failure of a new development from a technical aspect, or failure to consider all expenses of the project. [2]

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[1] Dean, op. cit., p. 568.

[2] Merrett and Sykes, op. cit., pp. 176-182.

There are several way of coping with the problem of risk which allow for the presence of uncertainty so that the analysis may proceed. One way is to improve the quality of the estimates of cash flows by using empirical data to adjust the estimates. If, for example, the firm's history of construction costs is such that they are usually exceeded by 15 per cent, then it would be proper to raise the estimates in the proposal by that amount.[1] Oftentimes, too, different people along the hierarchal review chain will cut the figures on a given project because they feel the figures are overly optimistic. The normal result of this procedure is to reward the responsible people if the results exceed the estimates. The fact that many profitable projects will have been passed over by this procedure is often not recognized. The tendency to underestimate on projects is in some direct proportion to the uncertainty of the situation. The recommended cure is to make the situation less threatening to the experts making the estimates and to be less willing to reward performance which exceeds expectations when the expectations were plainly set too low in the first place.[2]

The Variable Input Factor

A second means of risk allowance involves the use of more than one estimate of the input factors. Instead of restricting the estimators to

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[1]David B. Hertz, "Risk Analysis in Capital Investment," Contemporary Issues in Cost Accounting, ed. Hector R. Anton and Peter A. Firmin (Boston: Houghton Mifflin Company, 1966), p. 452.

[2]Donald H. Woods, "Improving Estimates that Involve Uncertainty," Harvard Business Review, XLIV, No. 4 (July-August, 1966), 96.

a single most probable figure, ranges of estimates may be requested which can be termed pessimistic, optimistic, and most probable. At this point, some further option is available since the three figures may be combined into one weighted figure or they may be maintained as a spread of estimates. If the figures are combined, weights such as 25 per cent for each of the high and low figures and 50 per cent for the most probable figure may be used. All of the weighted input factors may then be combined into a single most probable yield or present value, which will contain some expression of the uncertainty of the situation.[1]

Maintenance of the input factors as ranges of values will lead not to a single value of yield or present value, but to ranges of values. Rather than using only the extreme values of the input factors, values over the entire range of the estimates can be estimated and probability values assigned to each of the intermediate estimates. It is possible to program a computer in this fashion, allowing the different values for each of the input factors to occur in the computations in accordance with their assigned probability. By computing yield a great number of times (3,000 to 4,000), using the varying input values, the probability of any specific value of yield becomes calculable.[2]

The result of the probability approach to risk has the advantage of not citing one value as an answer to the problem, but rather gives a more

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[1] Bierman and Smidt, op. cit., p. 129.

[2] Hertz, op. cit., p. 459.

complete picture to management for their judgment. In Fig. 3, yield is shown both in the conventional way and as it would appear if computed by use of the variable input technique described. The probability approach appears to be an excellent way to include risk in the computations. Ranges of probable returns are more meaningful than a single most probable return.[1]

Comparison of Yield or Present Value to Cost of Capital

The yield or present value of a proposed project as computed may be compared to the cost of capital to determine if there is enough leeway for the uncertainty of the situation. A low-risk project with a yield of 15 per cent in a situation where the cost of capital is 10 per cent would probably be accepted. Perhaps some greater spread between projected return and the cost of capital would be required in riskier situations, but there must be some limit to the spread demanded, for there is no "haven of safety to be found by simply refusing to undertake risky development."[2]

The comparison of yield to the cost of capital is a relatively easy means of risk allowance, but how is this done when the present value method is preferred? One recommended way is to simply add a percentage to the cost of capital when discounting cash flows to the present time.[3] This

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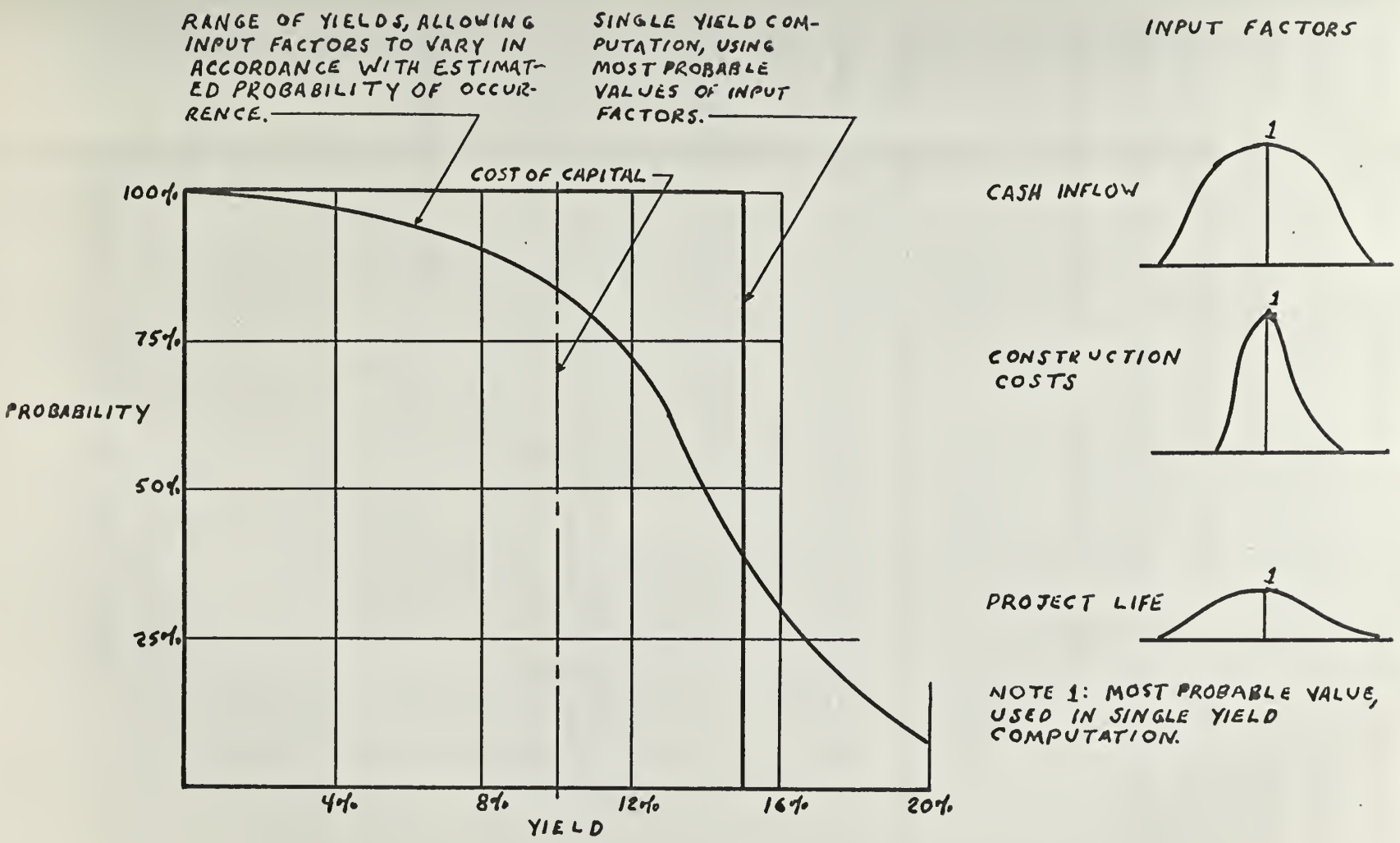
[1] Johnson, op. cit., p. 196.

[2] Merrett and Sykes, op. cit., p. 178.

[3] Anthony, op. cit., p. 621.



Source: Hertz, op. cit., pp. 459-463.

Fig. 3.--Yield vs. probability for an assumed investment project

is certainly a simple way, but how good is it? To begin with, it is technically unsound and incorrect since the risk originally assigned in this fashion is discounted by its own original value for each year of application. For example, a risk of .05 added to the cost of capital and then used to discount the future estimates back is understated by .05 times the risk for each succeeding year. To add risk of .05 to a cost of capital of .10 and then to discount back at .15 is equivalent to saying that

$$\frac{1}{(1+.1)^n} + \frac{1}{(1+.05)^n} = \frac{1}{(1+.15)^n}$$

which is not true. It could be rebutted that this inaccuracy is but a small penalty to pay for the ease of application which this method provides, and there is some truth in the rebuttal. There are other factors which weigh against this technique, however.

> The rate of discount used to compute the present value of the cash flows is the cost of capital. Should an investment with more uncertainty have a higher rate of discount than an investment with less uncertainty? The answer tentatively suggested is negative. Uncertainty recognized in computing the cash flows is more effective than using a higher discount factor for increased risk. [1]

Conclusions on Risk

A variety of methods is available for use in the imperfect techniques of incorporating risk into the capital investment analysis. Since risk itself is highly subjective, any concrete, single solution to an investment problem which has supposedly incorporated allowances for risk may

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[1] Bierman and Smidt, op. cit., p. 128.

be misleading. For this reason, the method of variable input factors is considered to be the most realistic of the risk methods discussed.

Classification of Projects

The classification of investment projects is a material problem because of the differing criteria placed on various types of projects.[1] In the broadest sense, all projects for a profit-seeking firm may be classified as either profit maintenance or profit adding projects. Within the dichotomy of either maintaining or increasing profits, the following subdivision of projects may be found:

Profit Maintenance

1. Replacement of existing facilities which will no longer function.
2. Improvement of existing facilities to circumvent competition.
3. Provision of new facilities which were accidentally omitted, but which are now necessary for the continuance of existing activities.

Profit Addition

1. Provision of facilities which will increase profits by new business or expansion.
2. Provision of facilities which will improve quality and permit higher price and profit margins.
3. Provision of facilities that will reduce cost of production and result in increased profit or volume of sales.[2]

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[1] F. K. Wright, "Project Evaluation and the Managerial Limit," Readings in Finance, ed. Harold A. Wolf and Lee Richardson (New York: Meridith Publishing Co., 1966), p. 65.

[2] Ray I. Reul, "Profitability Index for Investments," Harvard Business Review, Vol. XXXV, No. 4 (July-August, 1957), 119.

It is apparent that less risk will be attached to projects which are classified as profit maintenance types, than those projects which are classified as profit addition types. In fact, under the profit maintenance classification, many projects appear which are so obviously necessary as to really preclude any computations at all. These are the projects which, if management fails to approve, will mean the shut-down of an assembly line or the closing of a plant.[1] Yet, even within this "necessary" category there will be alternative solutions to the problem and the problem becomes one of selecting the least expensive of the mutually exclusive set of solutions. Even in this extreme case, investment analysis is not without meaning and benefit to the firm.

Summary

The profit-seeking firm has a variety of methods of evaluating a proposed capital investment which it can utilize in an analytical procedure. However, unless the firm utilizes a technique that embodies the principle of recognizing the differing values of cash flows in differing years, it is foregoing the most technically correct concept that has yet been developed in the field of capital investment analysis. The two principal methods of discounting cash flows, the yield method and the present value method, each have offsetting strengths and weaknesses. It is inconceivable that the rational firm would risk the investment of millions of dollars without

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[1] R. J. Cantwell, Financial Vice President of the Babcock and Wilcox Company, in a speech to the Navy Graduate Financial Management Program students, November, 1966.

careful application of the strengths of both methods.

Successful applications of the cash discount methods of analysis do not seem as apparent in the non-profit circumstance as they do to the private firm. Yet, even to the Federal Government, there appears to be conceptual basis for placing a premium on the delay of expenses and the acceleration of cash benefits. If this concept can be accepted, then all that remains is to seek out the ground rules of application of the procedures and principles presented in this chapter to the Navy. The ensuing chapters of the paper will examine these ground rules of application.

CHAPTER III

THE DEPARTMENT OF DEFENSE APPROACH TO CAPITAL INVESTMENT ANALYSIS

Background

As it was illustrated in the first chapter, the scope of capital investments within the Navy is large. Very broadly speaking, there are two sources for the input to any year's Military Construction Program: those projects that are required to support Department of Defense approved programs from the Planning, Programing, and Budgeting System (PPBS), and those projects that originate from the field. Field-originated projects will run the spectrum from those that are required to meet safety or sanitary requirements, such as sewage treatment plants, to those that are necessary for current operations, such as a pier replacement.

There is no intent to imply that the methods of analysis that were discussed in Chapter II are wholly applicable to all projects contained in the Military Construction Program. On the contrary, it will be unusual when a Navy project will show either a positive yield or net present value after being subjected to one of these two methods of analysis. Nevertheless, some projects will prove to be worth more than their installation cost, and many more which are not can be subjected to closer scrutiny by use of part of the

yield or present value analysis. As an example of the first, study of the Fiscal Year 1968 Military Construction Program shows that some sixteen projects with an estimated cost of $7,360,000 could possibly be justified on an economic basis--that is, where the discounted cost savings exceed the construction costs. One difficulty with an analysis of this type is that the projects were not prepared on an economic basis and the pertinent data necessary for the computations are not included in the project request.

Other projects which are not economic in an absolute sense may have relative economic features which are not now being explored. Generally speaking, all projects in the Military Construction Program are competitive, not mutually exclusive. Each project should represent the most economic means of satisfying a genuine requirement, even though it may not be economic in its own right. The preliminary steps to either the yield or present value analytical methods entail the setting down of all applicable costs and cash flows incident to each project. Whether the procedure includes the determination of yield or present value or not, the analysis of the data germane to the project and to alternate projects while still in the mutually exclusive stage would give some assurance that those projects that are finally manifested in the Military Construction Program represent the best of the alternatives. If any analysis of this type is now done, it is not coordinated, not uniform, and not frequent.[1] Despite efforts

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[1]Interview with Commander J. E. Washburn, CEC, USN, Military Construction Program Management Coordinator, Naval Facilities Engineering Command, March, 1967.

to prevent it from happening, the project which appears in the Military Construction Program is sometimes the one which will be the cheapest to install, not the one which will be the most economical to maintain and operate in the long run.

With this discussion as background, the difficulty of the role of the Department of Defense as a decision maker in the Military Construction process can be more fully appreciated. Somehow, Defense must evaluate project submissions from all of the services and decide which projects will be supported to the Congress and which projects will be deferred or deleted. Without a rather formalized method of capital investment analysis, it is not entirely clear just how the decision making should proceed in the majority of the projects.

Method of Analysis

A partial solution to the Department of Defense decision-making dilemma was proposed on August 25, 1966, with the promulgation of Interim Operating Procedure No. 6--Economic Analysis of Proposed Defense Investments (Op. 6) by Defense. Op. 6 is not designed for application to all military construction projects, but rather, as it states its purpose:

> This procedure provides specific instructions for evaluating proposed defense investment projects where the justification for such projects is economic.

Op. 6 directs all Military departments and Defense agencies to include a present value analysis of all costs and benefits incident to a project when that project is to be justified on an economic basis. The pertinent

data are to be submitted on two forms, samples of which were included with Op. 6. By following the directions included on the forms and explained in the directive, a present value analysis very similar to the type described in Chapter II will be conducted. The common denominator of all projects so analyzed is the Profitability Index, the ratio of the present value of the discounted cash benefits of the project to its investment cost. By ranking all proposed projects from all sources in the order of their Profitability Index, Defense will have a meaningful measure of their relative worth. The projects can then be supported in accordance with their standing on the Profitability Index list and, other factors notwithstanding, the most "profitable" projects will survive at the expense of their less worthy companions. Appendix I contains pertinent extracts from Op. 6.

In the Defense method of present value analysis, all investment costs associated with the project are to be considered. The investment costs include:

1. The costs of rehabilitating, modifying, or adding land, buildings, machinery, and equipment.

2. The costs of rehabilitating, modifying, or adding other capital items required to implement the project.

3. The costs of rearrangement, tooling, and training associated with the project.

4. The costs of freight, foundations, and installations required by the project.

5. Non-recurring costs of services received from others, both external to and internal to the DOD, when such costs are measurable.

6. Working capital changes required by the project.

7. Terminal value of existing equipment or facilities will be treated as a decrease in the investment cost.

The cash flows associated with the project are to be estimated for each year of the economic life of the project. Items to be included in the cash flows are the differential costs of the following:

1. Civilian personnel salaries, including an allowance for benefits not directly paid.

2. Military personnel salaries, including allowances to cover travel, moving expenses, and medical expenses.

3. Any other personnel costs not covered in categories one and two.

4. Operating costs.

5. Maintenance and repair costs.

6. Insurance costs, where applicable.

7. Overhead costs.

In accordance with the standard present value methods, the cash flows are then discounted to the present time and compared to the present value of the investment cost. The discount rate recommended by Defense is the subject of the next section of the paper.

The Cost of Capital

In Chapter II the cost of capital as meaningful to a profit-seeking firm was briefly touched on. The subject is controversial with respect to private industry; it is almost impossible with respect to the government. Op. 6 has the following comments about the cost of capital or discount rate:

> A discount rate is management's evaluation of two factors associated with Investment Analysis: (1) the interest cost of the money; and (2) the risk associated with the proposed project. The rate selected is then used to equate the present value of the benefits expected to the investment required to evaluate whether or not the proposed project is, in fact, justified.

The Defense Directive stipulates that three different discount rates shall be used in analyses as follows:

1. For long-term (10 years or more) noncancellable lease agreements a rate of 5 per cent will be used.

2. Lease-or-buy decisions involving lease agreements of ten years or less with cancellation clauses will be made using a 7 per cent rate.

3. A rate of 10 per cent will be used in the economic analysis of all other defense investment proposals.

An interview with Mr. Arnold Saitow of the Assistant Secretary of Defense (Comptroller) Staff on November 18, 1966, indicated additionally that Defense considered the cost of capital as the interest cost of money and that a good estimate of that interest cost was 5 per cent. No risk is considered to exist in the case of long-term noncancellable lease agreements,

2 per cent risk is considered to exist in the shorter cancellable lease situations, and 5 per cent risk is added to the interest rate for all other cases.

The interview with Mr. Saitow shed further light on the subject of risk and cost of capital. There are elements of the Comptroller's Staff that wanted to use a 15 per cent cost of capital or discount rate on the premise that this figure approximates the marginal return on investments which are made in industry, or the private sector of the economy. After appropriate discussions, Defense made the decision to go with the 10 per cent interest-plus-risk approach.

A great deal of hypothesizing is possible on the topic of cost of capital for the government. Equating the governmental cost of capital with the marginal return of industry offers an interesting avenue of approach. It is supposed that the rationale in this case is that a dollar not spent by the government would represent a dollar not collected in taxes and would therefore become the marginal dollar to be invested in industry. This argument would appear to quickly break down when one realizes that there is no straight line relationship between governmental spending and private investment, but that the two factors are related by the level of employment, the tax rate and structures, and marginal propensities to consume, at the very least.[1] Although it might be possible to compute the governmental cost of capital at any given moment by this means, the computations would be lengthy, the

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[1]David J. Ott and Attiat F. Ott, Federal Budget Policy (Washington: The Brookings Institution, 1965), pp. 54-79.

results short-lived because of the dynamic factors involved, and the theory is uncertain.

A second avenue of approach which can be briefly explored is a straightforward business approach. It would be possible to strike a balance sheet of governmental assets, liabilities, and net worth at any period of time. The question, then, is quickly raised of how to evaluate the equity portion of this "business." It could be presumed that every United States citizen holds equal share in the government so the problem now could become one of determining the market value of each of the 200 million shares of the equity. If we knew the market value of the shares plus the market value of the debt instruments, which would be easy to calculate, then we could quickly determine the approximate cost of capital.[1] The absurdity of this approach is now apparent: Who can evaluate the worth of American citizenship?

The approach of associating the cost of capital as the specific cost of funds which will be used for a given project holds the greatest hope of theoretical validity. This method is not without its supporters in the general theory of the cost of capital. If it is then considered that the Military Construction Program is supported entirely from funds that have been borrowed to fill the annual deficit, the use of 5 per cent interest charges as the cost of capital makes a great deal of sense. On this point, the use of

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[1] J. Fred Weston, Managerial Finance (New York: Holt, Rinehart and Winston, 1963), pp. 234-235.

5 per cent as the cost of capital for capital investment analysis , Defense appears to be on solid ground.

Risk

The special difficulty of combining risk and the cost of capital in a single discount rate has already been discussed in Chapter II. Although some authors would hold that it is an acceptable way to allow for risk, at least better than no risk allowance, the general opinion appears to be that a far better way is to account for risk by adjustment in the figures used in the cash flows.[1] It appears to be a sanctimonious act on the part of Defense to state categorically that there is no risk in this type of project, 2 per cent risk in that type of project, and 5 per cent risk in the third type of project, and then to follow these judgments with the statement that:

> A project with a profitability index of less than 1.0 should not be undertaken unless there are compelling qualitative considerations which outweigh the economics involved.[2]

This judgment is made with all the outward appearance of a great depth of experience with the Department of Defense economic project, when in actuality there is no experience to date.

Yet another reason for disagreement with the Defense method of coping with risk lies in the fact that the entire spectrum of the economic project must be classified as cost-saving investments, and at least one

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[1] Bierman and Smidt, op. cit., p. 55.

[2] Department of Defense, Interim Operating Procedure No. 6--Economic Analysis of Proposed Defense Investments, August, 1966, p. 5.

author believes cost-saving investments to be virtually risk free.[1] One can only speculate what the reaction of Merrett and Sykes would be to the proposition that a cost-reduction project must survive a risk discounting which is equal to the cost of capital involved, but it must be presumed that the reaction would be negative. It is also felt in this quarter that the risk of 5 per cent which Defense stipulates must be added to the 5 per cent cost of capital in the analysis of the bulk of economic projects is not realistic in all cases. Most likely, there will be many bona fide cost-reduction projects which will be disqualified if the associated cash flows must survive a 10 per cent discounting.

Competing Versus Mutually Exclusive Projects

The Defense directive, Op. 6, while limiting itself to the economic project, contains many valid concepts in capital investment analysis which have much broader application. The point has already been made that the Military Construction Program consists of competing projects, but that each of these projects must be the survivors of a group of mutually exclusive projects. Many of the principles presented in Op. 6 could be applied to all projects while they are mutually exclusive, whether the resulting project is economic or not. It was never the intention of Defense to apply these principles beyond the economic project,[2] but the point made here is that the principles are applicable and should be applied.

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[1] Merrett and Sykes, op. cit., p. 209.

[2] Interview with Arnold Saitow, Staff member of the Assistant Secretary of Defense (Comptroller), November, 1966.

Op. 6 stipulates that the profitability index of each project shall be the basis upon which it shall be judged in comparison to other projects. Chapter II illustrated the fact that the profitability index was a valid comparison factor in a competing situation but that it may not give the right decision in a mutually exclusive situation. In this regard, since the only application of Op. 6 will be in competing situations, the profitability index as presented by Defense is a useful device.

Summary

In the basic concepts of its creation, Op. 6 is a useful tool which will help establish order in a small segment of the Military Construction Program. Where there was little organized analysis, the Defense Department has tried to fill the gap with a procedure which is generally sound and which can be applied by all segments of the Defense Establishment. As is so often the case in an initial attempt at navigating uncharted waters, the first step does not solve all the problems but rather forms a nucleus for building constructive, useful policy. Such is the case with Op. 6, which while not without weakness, has much strength from which widespread analytical techniques can be developed and applied throughout the Navy.

In the chapter to follow, a technique of capital investment analysis for the Navy will be proposed which, while embodying much of Op. 6, will also propose to strengthen the felt weaknesses of that directive.

CHAPTER IV

A RECOMMENDED APPROACH TO CAPITAL INVESTMENT ANALYSIS IN THE NAVY

General Factors

In making recommendations for specific ways of analyzing capital investments in the Navy, it is recognized that, while there is no one procedure which can be made to fit all situations, there are certain factors that have general applicability. In even the most improbable of situations, where the parameters are such that there is seemingly no correlation with the theory of capital investment analysis as discussed in Chapter II, there are some things that can be done to sharpen the judgment of the decision maker.

Cash Flows

The first step in the analysis of a proposed investment project is the setting down of the associated cash flows. As simple and elementary as this advice may seem, it may well be the most difficult factor in the procedure. A great deal of experience and foresight is required first to accurately estimate the types and magnitudes of costs which surround a given project, and then to place these cost elements in the time frame in which they will occur.

The cash flows which are associated with a project can be roughly categorized into investment costs and operating/ maintenance costs. The Defense directive, Op. 6, sets forth the cost categories which are to be considered in investment analysis and they have been listed in Chapter III. No change is recommended to the Defense approach to the categories of cash flows, but it is recommended that ranges of values which represent high and low possibilities of occurrence be used rather than a single most probable estimate. The range of values selected should be such that the estimator has roughly 95 per cent confidence that the actual cost will fall within the stated limits. The third figure in the estimates is the most probable result, which is the figure the estimator would have given had he been held to a single figure.

Examination of the cash flows may provide valuable insight into the value of a project, even without further analysis. At the very least, the process of contemplating and quantifying all costs to which a proposed project will commit an organization is a step towards insuring that no significant element is overlooked that could later prove embarrassing.

Cost of Capital

When project analysis beyond the simple examination of the cash flows is warranted, techniques from the discounted cash flow method of analysis will provide the most valid means of analysis. It is recommended that the cost of capital used in all discounted techniques be 5 per cent, which supports the recommendation made by Defense. Rationalization of

the 5 per cent figure can be made by the simple assumption that all capital investment funds emanate from borrowed capital and that the approximate cost of that capital is 5 per cent. The assumption is admittedly oversimplified, as discussed in Chapter III, but other attempts at determination of a possibly more valid cost of capital for the Navy would be over-complicated.

Risk

It is firmly believed that the best approach to inclusion of risk in the analytical process lies in the adjustments to the cash flows. The recommendation to use ranges of values instead of a single estimate for factors bearing on the project is a first step in risk allowance. Narrow spreads in the values given by the estimator indicate high confidence in the estimates, while wide spreads indicate a lack of confidence. Risk, in either case, exists in some proportion to the confidence expressed by the estimators.

The most complex means of risk allowance was discussed in Chapter II, wherein the input factors (cash flows) to a project would be allowed to vary in accordance with their estimated probability of occurrence, while a computer is programed to compute the project's yield a large number of times. The resulting values of yield can be plotted against their probability of occurrence, resulting in a better understanding of the risks that are involved with the project.

The general technique of risk handling just briefly described again has uses other than in the discounted cash flow methods of analysis.

Consider the case of a large-scale, unusual type of project, where the elements of cost are not at all certain. In this case the annual cash flows are not considered since we are only concerned at first with the construction or investment costs. Use of the most probable cost elements might give an initial total estimate of, say, $25 million, which might be acceptable. By use of the variable cost elements and a properly programed computer, different final costs may be computed a large number of times. Analysis of the resulting costs may show that the original $25 million cost estimate was exceeded 70 per cent of the time, which would indicate a probability of 30 per cent for completing the construction within the original estimate. Further examination may show only a 50 per cent chance of staying within $35 million and the project, revealed in this light, may never be undertaken.

In the majority of cases, risk determination will be undertaken by a much less complex means than by the method of the computer. Combination of all the optimistic factors followed by combination of the pessimistic factors will indicate the extreme possibilities of the resulting costs. A few sample combinations such as holding all factors but one to their most probable values and allowing one factor to vary between its extremes will give an indication of the sensitivity of the varying factor. In brief, selected computations of the result, whether working with yield, present value, or simply the construction costs, will give a much better indication of the risks involved than will a single computation using the single most probable values.

The general factors of analysis which have been discussed thus far have applicability in most of the instances of capital investment analysis in the Navy. More specific recommendations will follow in the next three sections of the chapter.

The Mutually Exclusive Situation

All projects emerge from a mutually exclusive environment because of the large variety of possible solutions to any construction problem. In those situations where there is an apparent significant difference in the costs of the alternative solutions, it is recommended that a present value analysis be made to determine the least cost method of fulfilling the requirement over a period of time.

In Table 7 which follows, assume that a requirement is generated to accomplish some function. The nature of the function is not important; it could be a battery charging facility or an air conditioned class room. Preliminary design investigation shows three technically sound ways to meet the requirement. Project A is the least expensive initially, but it has no automatic equipment and entails a high annual operating cost once installed. Project B incorporates some automatic equipment at a higher initial cost, but results in lower annual operating costs. Project C might include a fully automatic mechanical system and better quality materials which reduce annual operating and maintenance costs. All three projects have an estimated ten-year life and for simplicity the annual cash flows are assumed to be equal for each year of the project's life.

TABLE 7

HYPOTHETICAL INVESTMENT ALTERNATIVES WITH COST RANGES

Project	Construction Estimates ($000)			Annual O & M Costs ($000)		
	Low	Probable	High	Low	Probable	High
A	$ 90	$100	$115	$19	$22	$26
B	115	120	130	18	20	25
C	125	130	140	15	17	20

The first comparison of the three projects should involve the lowest cost project A and the next most costly project B. The difference in the construction estimates shows that project B could initially cost from $25,000 to $15,000 more than A, with a most probable difference of $20,000. Similarly, the annual Operating and Maintenance costs of project B could be from $1,000 to $2,000 less expensive than project A. Over a ten-year period the most probable annual savings of $2,000 would just equal the most probable differences in construction costs of $20,000. It is therefore immediately obvious that if the difference in cash flows were discounted back at 5 per cent, there would be a net negative present value and it can be seen that the increased cost of project B is not an economically justified one.

Turning next to a comparison of project C to project A, it can be seen that the difference in construction costs could vary from $35,000 to $25,000, with a most probable difference of $30,000. The difference in

annual cash flows could vary from $4,000 to $6,000 with a most probable difference of $5,000. If an annual flow of $5,000 for ten years were discounted back at 5 per cent, the present value of the flows would be $5,000 x 7.72, or $38,500. Since the present value of the flows is greater than the present value of the construction cost differential required to obtain the flows, project C appears to be worth the extra construction cost.

Further comparisons of the two projects, A and C, would reveal that the most disadvantageous combination of cost factors between them would show project A to be the least expensive through time, but that the probability of this combination of factors occurring would be rather small. An additional assumption made in this case is that conditions which would cause either the high, most probable, or low costs to occur in the case of one project would also prevail in the case of another project. Thus, there is no comparison made between the low factors of one project and the high factors of another project. Such comparisons could easily be made if, in the opinion of the person making the analysis, conditions could exist which would cause that pattern of behavior.

None of the three projects illustrated are economic in an absolute sense and once project C is selected, if that is the decision to be made, it is submitted for consideration in the Military Construction Program. The major positive value of the illustrated procedure of analyzing mutually exclusive projects is the assurance that we have selected that project which will be the least expensive to the Navy in the long run.

The Competing Situation

In Chapter II it was seen that, while the present value method provides the most direct and simple means of analyzing mutually exclusive projects, the yield method has certain advantages in analyzing competing projects. The very great difficulty in applying this rationale to the Navy's situation lies in the fact that most of the competing projects are not economic. There is simply no way of rendering an economic judgment on the majority of projects in the Military Construction Program.

Consider again the three projects discussed in the previous section. If by some chance project A had been originally approved and installed, and some years later project C is recognized as a less costly way of meeting the same requirement, it would not be economic to replace the A installation with project C. The savings inherent in project C must in this instance amortize not only the difference in costs of the two projects, but also the full cost of constructing project C. The annual savings inherent in project C would have to equal or exceed $\frac{\$130,000}{7.72} = \$16,900$ before it could be classified as, and justified on, an economic basis.

If the same three projects are presented as fully competitive to replace similar facilities already in existence and are not presented on an economic basis, then the presumption must be made that the present method is more economical than the proposed one. With this rationale, which is admittedly a negative one, any project that appears in the Military Construction Program as a replacement item and is not economically

justified, must be presumed to be economically inferior to the facility it would replace. Justification of this type of project must then proceed on some basis other than that presented in this paper. One truism is obvious: a project is either economically justified or it is not. Since the majority of the projects in the Military Construction Program will not be economical, the final supporting rationale for these projects must be generated from some other source.

The Economic Project

From time to time, some new way of accomplishing a necessary function will appear which is so efficient that the annual savings to be realized by implementation of the new method will have a greater value than its installation cost. Economic projects have such potential importance that it is proposed that they be grouped and separately considered from the rest of the Military Construction Program. There should be little question as to the sponsorship and eventual funding of properly analyzed economic projects. Each economic project represents both an opportunity to accomplish some given function at a lower cost and a means of accomplishing that function more effectively.

It has been previously mentioned that some sixteen projects in the 1968 Military Construction Program with an aggregate value of about $7,360,000 have a potential to be economically justified. If it developed that these projects could all be justified at an annual yield rate of only 5 per cent, there is an obvious potential for savings which would amount to

$368,000 annually. It is further hypothesized that installation of a system for handling economic projects which resulted in a high rate of project approval would provide high motivation for military managers to actively search for and submit plans for greater economies in the conduct of Defense matters. The potential reward of a viable system of economic project submission is high indeed.

After initial screening of potential economic projects by a present value analysis, it is recommended that the project yield be computed and that the value of yield so calculated be used as a means of ranking between the various competing economic projects. In those instances where risk is determined to be unusually high or where the initial investment costs are unusually large, it is further recommended that the variable input factor means of determining risk be used, as previously described. Since only experience which is yet to be gained can determine what the "unusual" cases of risk and costs will be, no specific recommendation in this area can be reasonably made.

If the recommendations which have been made in this section are followed, a certain number of economic projects will become a separate part of each year's Military Construction Program. These projects will be ranked and recommended for funding in the descending order of their calculated yields, unless other factors, such as requirement, dictate some realignment of the yield-oriented priority list. There would then, hopefully, be little problem in obtaining the required funds for the implementation.

of the economic projects. Recognized success with the economic project would encourage more military managers to search for an ever-increasing volume of cost-reducing projects which would, in turn, result in ever-increasing efficiency throughout the Navy.

CHAPTER V

APPLICATION OF CAPITAL INVESTMENT THEORY TO A POTENTIAL ECONOMIC PROJECT

Description of the Problem

Project P-406, entitled Public Works and Ships Division Facilities, 2nd Increment, located at the Naval Station, Adak, Alaska, was sponsored by the Navy for inclusion in the Fiscal Year 1968 Military Construction Program. A copy of the project as it appeared in the Budget Estimate format of the Department of the Navy Military Construction Program, Fiscal Year 1968 publication, is included as Appendix II. This project has been selected for inclusion in the paper and will be used to demonstrate the techniques of capital investment analysis both as advocated by the Department of Defense and as recommended in Chapter IV.

The selected project is of a type which rather frequently appears in the Military Construction Program: the consolidation project, which proposes to eliminate a number of locations and consolidate the function therein contained to a single location. In the case of project P-406, the Public Works Department and the Ships Department at Adak, Alaska, currently conduct certain operations out of twenty-two scattered Quonset huts and wooden buildings which they wish to consolidate into two warehouses. The warehouses have been made available by a prior consolidation of

warehouse operations at Adak. Two stages in the construction are represented by the two projects, P-405 and P-406. Project P-405 was approved and funded during Fiscal Year 1967 and its estimated cost of $850,000 must be added to the estimated cost of project P-406. The savings which are estimated will accrue as a result of the consolidation must amortize both projects in order for them to qualify as economic.

The Project Data

Project P-406, as written for inclusion in the Military Construction Program, indicated that its estimated cost of $1,400,000 would result in one-time savings of $1,677,000 in repair costs as well as recurring annual savings of $147,000, because of decreased maintenance and operating costs. Since the project write-up contained little back-up data, it was necessary to obtain additional facts and data bearing on the project.

Contact with Commander J. E. Washburn, CEC, USN, the Military Construction Program coordinator at the Naval Facilities Engineering Command (NAVFAC), established common interest in the economic justification of the selected project. Correspondingly, in the interest of obtaining prompt response, the required additional data were requested on an official basis. NavFac letter 05C/JEW:lm of 28 December 1966, which requested the additional information, and the response thereto from the Northwest Division of NavFac, are enclosed in Appendix III. The NavFac interest in the matter became increasingly obvious with the rejection of support for the project by the Department of Defense.

The Additional Data

Supporting data for the annual savings which were estimated at $147,000 in the project write-up indicate a reduction in that figure to $90,620. The significant elements in the estimated annual savings are civilian labor savings of $89,260 and utilities savings of $28,500. Of singular significance is the estimated cost increase in maintenance of $27,140 annually, due entirely to the fact that present maintenance is restricted to break-down repairs only. The net of the three figures is the annual estimated savings of $90,620.

The working capital changes in the supporting data show an estimated decrease in required inventory of $1,200 and an estimated decrease in machine tools of $68,700. The inventory decrease will be counted, but since the machine tools would ordinarily be capitalized and the salvage value is not known, no credit will be given for the decrease of $68,700. It should be pointed out that credit could be taken for the machine tools in the amount of their replacement cost in the estimated year of replacement, since the project will result in this eventual cost avoidance.

The estimated repair costs to the existing facilities, should the proposed project be rejected, are $1,677,400. These cost avoidance savings are credited in the amounts of $500,000 in each of the first two years of the project life and $677,444 in the third year of the project life. The decision to take credit for these savings in this fashion is wholly arbitrary. If the total estimated repair costs were credited during the first year, the

resulting present value of the benefits would be considerably higher. Conversely, taking credit for the repair costs in later years would effect a reduction in the present value of the benefits. The compromise of spreading the repair costs over the first three years of the project life is made in the interests of neither aiding nor handicapping the project too severely.

The difficulty of communicating is amply demonstrated in the letters of Appendix III. The intent was to obtain the best estimates of the lowest and highest annual costs which will result from implementation of the project. The response provided only the most probable of these estimates and time did not permit clarification. For the purposes of the paper, estimates of the high and low values can and will be assumed. The rest of the data used in the computations which follow are either self-obvious or are explained in their proper place.

The DOD Approach

Chapter III describes the Department of Defense approach to capital investment analysis as a present value method, using a 10 per cent discount rate, which combines 5 per cent for the assumed cost of capital and 5 per cent for the assumed risk. The computations and displays of data which follow in Tables 8, 9, and 10 are in the format desired by Defense.

The evaluation of the project, in accordance with the Department of Defense method, shows that the project is not economic and that, since its profitability index is less than 1.0, it should not be undertaken unless there are compelling qualitative considerations.

TABLE 8

ACTUAL PROJECT FACTORS, DOD METHOD

Project Title: Public Works and Ships Division Facilities, 2nd Increment.

Description of Project: Conversion of portions of warehouse buildings T-1441 and T-1443 to permit relocation of Public Works and Ships Department functions, and demolition of 22 presently used buildings.

A. Investment:	Dollar Amount
1. First increment, project P-405	$ 850,000
2. Second increment, project P-406	1,346,400
3. Demolition of existing facilities	76,100
4. Working capital changes (-)	1,200
5. Terminal value, existing facilities	-0-
6. Net Investment	$2,271,300
B. Present Value of Benefits (from succeeding form)	$2,147,014
C. Profitability Index (B ÷ A)	.948

TABLE 9

SUMMARY OF PROPOSED SAVINGS, DOD METHOD

Year	Personnel Costs		Rehabilitation Eliminated	Operation and Maintenance		Total Benefits
	Old	New		Old	New	
1	$1,574,000	$1,485,000	$500,000	$64,500	$63,140	$590,360
2	"	"	500,000	"	"	590,360
3	"	"	677,400	"	"	767,760
4-20	"	"	-0-	"	"	90,360

TABLE 10

DERIVATION OF PRESENT VALUE OF BENEFITS, DOD METHOD

Year	Benefits	10 Per Cent Factor	Present Value
1	$ 590,360	.91	$ 537,228
2	590,360	.83	489,999
3	767,760	.75	575,820
4-20	90,360	6.02	543,967
Total	$3,485,600		$2,147,014

As an interesting sidelight, the decision to spread the repair or rehabilitation costs over the first three years may now be viewed in retrospect. If credit for the rehabilitation cost avoidance had been taken wholly

in the first year, the present value of the benefits would have been increased by $148,384, or enough to have offset the investment cost by some $24,000. The originally established cash flows will be adhered to, however, as a more likely commitment of funds.

The Recommended Approach

Examination of the project shows that there are five principal factors, subject to variance, which could affect the outcome of the economic evaluation:

1. Construction (investment) costs of the two increments.
2. Rehabilitation costs saved by installing the project.
3. The economic life of the project.
4. Annual maintenance cost differential.
5. Annual utilities (operating) cost differential.

Assumptions Made Concerning the Input Factors

It was earlier indicated that ranges of values for the various input factors were not received from the field, except for the project life. The first assumptions were made in regard to establishing ranges of values and probabilities of experiencing the various assumed values.

It was assumed that the investment costs and the rehabilitation costs would vary from (-) 5 per cent to (+) 10 per cent from the most probable figures given. Probabilities of the low values occurring were estimated to be .2, the most probable values were assigned a probability of .5, and the

high values were assigned a probability of . 3.

The pattern of probability assignment for the estimated life of the project was reversed with respect to the investment and rehabilitation costs. In the case of the economic life, the low estimate of eighteen years was assigned a probability of . 3, the most likely estimate of twenty years was assigned a probability of . 5, and the high estimate of twenty-five years was assigned a probability of . 2.

The two factors of annual estimated maintenance and utilities costs were first of all combined into a single figure. It was then considered that since this combination of factors was perhaps the most difficult of all to estimate, the high and low figures were both set as (±) 10 per cent from the most probable value. The high and low annual savings were each given a . 3 probability of occurrence, resulting in an assignment of . 4 probability for the most likely value. Table 11, which shows the assumed values, appears on the following page.

Two items of information are contained in the columns under "Code." The letter designation will be later used as an easy reference to the corresponding value of the estimate when various combinations of factors are considered. The decimal value in parentheses is the assigned probability of the estimated factor.

These data can now be combined in all possible ways to determine what the yield will be for each combination. If a computer were available, and if the scope of the project warranted its use, several refinements

TABLE 11

ACTUAL PROJECT WITH ASSUMED FACTORS

Input Factor	Low		Most Probable		High	
	Estimate	Code	Estimate	Code	Estimate	Code
Investment Costs	$2,158,000	A(.2)	$2,271,000	B(.5)	$2,494,000	C(.3)
Rehabilitation Costs	1,593,000	a(.2)	1,677,000	b(.5)	1,845,000	c(.3)
Life	18 years	D(.3)	20 years	E(.5)	25 years	F(.2)
Annual M. & O. Savings	80,000	G(.3)	90,000	H(.4)	100,000	I(.3)

could be included in the cash flows and easily handled. For example:

1. The cash flows could show greater horizontal differentiation, assuming cost variances of 1 per cent or less, with a correspondingly finer breakdown of the probabilities.

2. Future labor cost increases could be shown, based on historical records of past increases.

3. The effects of rising construction costs could be incorporated, based on historical records for the specific geographical location being considered.

4. The rehabilitation cost avoidance savings could be shown in varying patterns.

These refinements would add credibility to the analysis, but manual manipulation of the data is already a formidable task, with 3^4, or 81, possible combinations. Two further assumptions will considerably reduce the computational load, however.

Consider that the investment cost factor and the rehabilitation cost factor, since they both involve construction work under similar conditions, will vary together. In other words, if the estimate has been high in one factor, it will probably be high in the other factor, too. With this assumption, assignment of factor A will mean assignment of factor "a" as well, reducing the total number of possible factor combinations to 3^3, or 27--a more reasonable manual workload.

The final assumption made concerns the pattern of the rehabilitation costs. In all cases, it is assumed that the savings realized by not having to rehabilitate existing facilities will be $500,000 in each of the first two years and that the variation in the estimates is always fully absorbed in the third year. Therefore, the difference between the high and low estimates of $252,000 will always be reflected in the third year cash flow only, with all other years remaining unaffected.

The Most Probable Yield

Selection of the most probable figures, B, E, and H, with a combined probability of occurrence of .5 x .5x .4 = .1, or 10 per cent, produces a yield of 8.48 per cent, as shown in Table 12.

TABLE 12

ACTUAL PROJECT, MOST PROBABLE YIELD

Investment	Year	Annual Flow	Discount Factor 8%	Present Value	Discount Factor 9%	Present Value
$2,271,000	0					
	1	$590,000	.93	$ 549,000	.92	$ 542,000
	2	590,000	.86	507,000	.84	496,000
	3	767,000	.79	606,000	.77	590,000
	4-20	90,000	7.27	655,000	6.60	594,000
$2,271,000				$2,317,000		$2,222,000

$$\text{Yield equals } 8\% + \frac{\$2,317,000 - \$2,271,000}{\$2,317,000 - \$2,222,000}$$

$$\text{Yield equals } 8\% + \frac{\$46,000}{\$95,000} = 8.48\%$$

This single computation is the equivalent of the Department of Defense method of analysis wherein the most probable factors have been considered. It now becomes clear that the 5 per cent cost of capital is met by the project, but that only 3.48 per cent is available to meet the 5 per cent risk demanded by Defense. The point of departure between the Defense method and the recommended method has now been reached. By combining all the factors in all the possible combinations, it should become obvious

whether the 5 per cent risk demand of Defense is reasonable or not in the case of this specific project.

Computation of Yields of Varying Input Factors

The computation of yields of the varying input factors has been done similar to the yield computation in the previous section. The computations were rounded to the nearest whole per cent. The results are listed in Table 13.

The weighted total yield varies from the previously computed most probable yield of 8.48 per cent because of the assumed limits and assigned probabilities of the input factors. A better description of the project's predicted behavior can be given by grouping the yields, as in Table 14, and constructing a yield versus probability curve, as illustrated in Chapter II.

The plot of Yield versus Probability for the variable factor risk accountability is shown in Fig. 4.

One more task remains to be done before the results can be evaluated. In order to determine what the range of yields would be if the investment cost and rehabilitation cost factors were not locked together, it is necessary to compute yield under the most and least desirable combinations of factors, as shown in Tables 15 and 16.

TABLE 13

RESULTS OF VARYING INPUT FACTORS, ACTUAL PROJECT, RECOMMENDED METHOD

Factor Combination	Probability of Combination	Computed Yield	Weighted Yield
ADG	.018	8%	.144%
ADH	.024	9	.216
ADI	.018	10	.180
AEG	.030	8	.240
AEH	.040	9	.360
AEI	.030	10	.300
AFG	.012	9	.108
AFH	.016	10	.160
AFI	.012	11	.132
BDG	.045	7	.315
BDH	.060	8	.480
BDI	.045	9	.405
BEG	.075	7	.525
BEH	.100	8	.800
BEI	.075	9	.675
BFG	.030	8	.240
BFH	.040	9	.360
BFI	.030	10	.300
CDG	.027	6	.162
CDH	.036	7	.252
CDI	.027	8	.216
CEG	.045	6	.270
CEH	.060	8	.480
CEI	.045	9	.405
CFG	.018	7	.126
CFH	.024	8	.192
CFI	.018	9	.162
Totals	1.000		8.205%

TABLE 14

GROUPING OF COMPUTED YIELDS, ACTUAL PROJECT, RECOMMENDED METHOD

Yield	Probability (Per Cent)	Probability Sum (Per Cent)	Cumulative Probability Sum (Per Cent)
11%	1.2%	1.2%	1.2%
10%	1.8%		
	3.0		
	1.6		
	3.0	9.4%	10.6
9%	2.4%		
	4.0		
	1.2		
	4.5		
	7.5		
	4.0		
	4.5		
	1.8	29.9%	40.5
8%	1.8%		
	3.0		
	6.0		
	10.0		
	3.0		
	2.7		
	6.0		
	2.4	34.9%	75.4
7%	4.5%		
	7.5		
	3.6		
	1.8	17.4%	92.8
6%	2.7%		
	4.5	7.2%	100.0

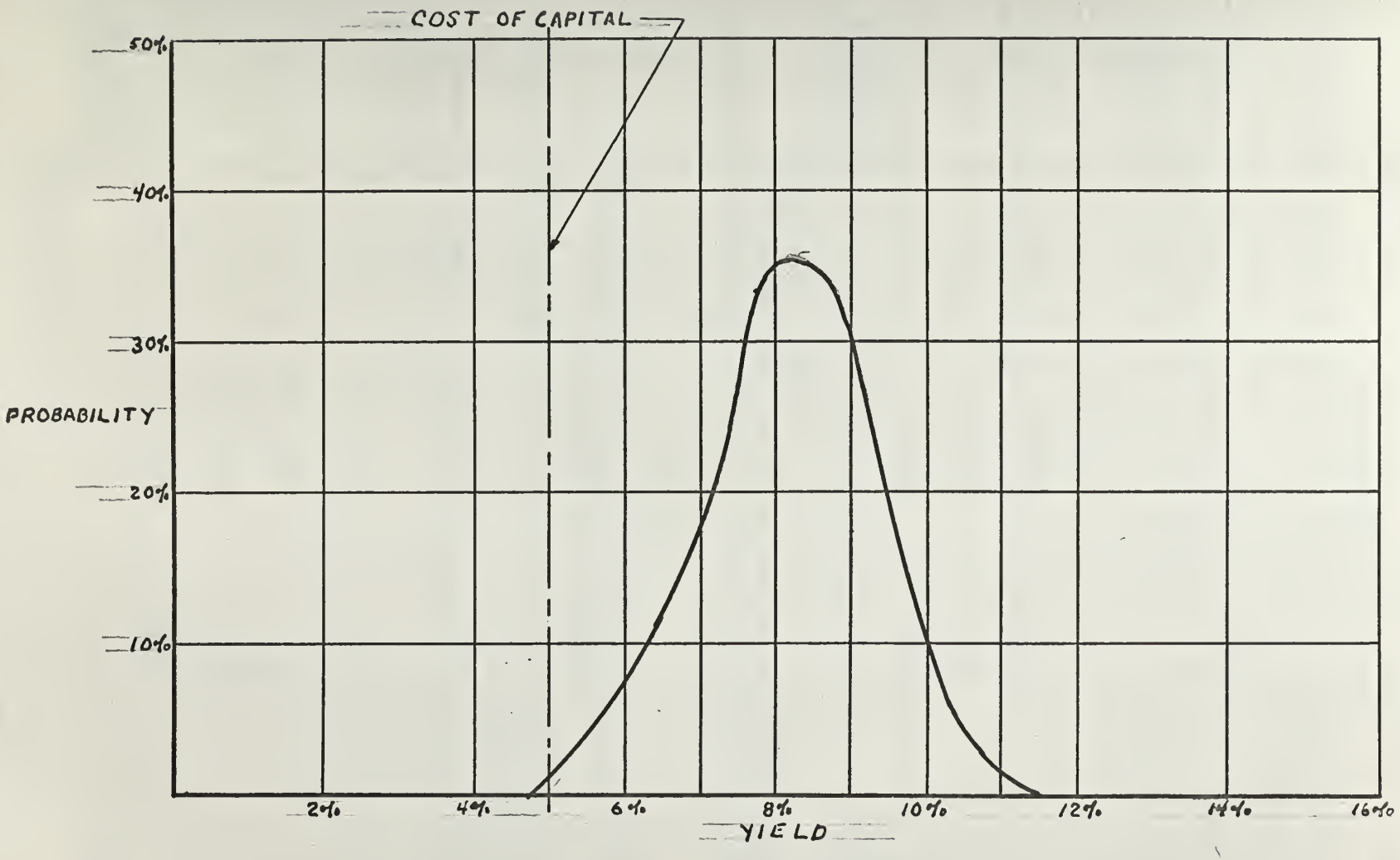

Fig. 4. --Results of variable factor risk accountability

TABLE 15

COMPUTATION OF LOWEST YIELD, ACTUAL PROJECT, RECOMMENDED METHOD

Investment	Year	Annual Flow	Discount Factor 4%	Present Value
$2,494,000	0			
	1	$580,000	.96	$ 556,000
	2	580,000	.92	534,000
	3	673,000	.89	599,000
	4-18	80,000	9.88	790,000
$2,494,000				$2,479,000

Least Yield: 4%
Probability: .3 x .2 x .3 x .3 = (C x a x D x G) = .0054

TABLE 16

COMPUTATION OF HIGHEST YIELD, ACTUAL PROJECT, RECOMMENDED METHOD

Investment	Year	Annual Flow	Discount Factor 13%	Present Value
$2,158,000	0			
	1	$600,000	.88	$ 528,000
	2	600,000	.78	467,000
	3	945,000	.69	652,000
	4-25	100,000	4.97	497,000
$2,158,000				$2,144,000

Highest Yield: 13%
Probability: .2 x .3 x .2 x .3 = (A x c x F x I) = .0036

Examination of all computations shows an 83% probability of obtaining a project yield of between 7 and 9%, inclusive. Even allowing the investment cost and the rehabilitation cost to vary independently would produce only about a .5% chance of attaining a yield less than a 5% assumed cost of capital. Numerous other statistics could be constructed out of the computations, but the point has been made: analysis of the project by the recommended method would result in its approval, whereas analysis by the Defense method would result in its disapproval.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Summary

In the introductory chapter, the basic research question and four subsidiary related questions were raised. Restatement of these five questions, accompanied by comments based on material covered in the paper, will provide the basis of summation.

Are the Theoretical Techniques of Capital Investment Analysis Applicable to the Analysis of Capital Investment Projects in the Navy?

Two methods of capital investment analysis have been examined in the paper and both methods have been derived from the theoretically correct discounted cash flow technique, developed for use by the profit-seeking firm. The present value method, advocated by the Department of Defense, has been limited in its application to those situations where a project has an absolute economic advantage over some current system. The method which has been recommended in the paper, advocates the use of the present value technique for mutually exclusive situations and the use of the yield technique for competing situations.

Analysis and application of the method proposed by the Department of Defense and the method proposed in this paper have shown the feasibility

of adoption of theoretical methods of capital investment analysis to Navy investment problems.

What Are the Techniques of Capital Investment Analysis?

Chapter II provided a general overview of six basic capital investment analysis techniques, with an in-depth discussion of some of the major controversial points, surrounding the yield and present value techniques. It was shown that only one basic method--the discounted cash flow--was theoretically correct, and that the two techniques of applying the method--the present value technique and the yield technique--each have their strengths and limitations. Methods other than the discounted cash flow method all fail to recognize the time value of money and are therefore limited to certain specific uses.

What Techniques of Capital Investment Analysis Have Been Implemented in the Navy?

Apart from the recent Defense directive on the subject of capital investment analysis, no uniformly applied technique has appeared in the Navy. The two main sources of Military Construction Projects, those required to support Defense-approved plans and programs and those generated by military managers in the field, are each justified in their own way. In the case of those projects which are generated to support programs, once the program has been approved, project approval becomes axiomatic: the need has been established. In the case of projects which are generated

from the field, there is no clear-cut guidance as to what constitutes a good or a poor project. Project analysis to date has been left to the imagination of the individual military manager.

Should Capital Investment Projects in the Navy Be Required To Show a Return? If so, How Much of a Return?

The techniques recommended in this paper provide a method of insuring that every project submitted for consideration in the Military Construction Program represents the most economical means of solving the problem at hand. Beyond the preliminary analysis, there will be few projects which will be economic in an absolute sense, and in these instances, capital investment analysis is of little assistance. For those few projects that prove to be economic in the sense that over-all savings made possible by the project are worth more through time than the project investment cost, the techniques available and recommended for their analysis are identical to those which would be used by a profit-seeking firm. In the case of the economic project, a required return on the investment is in order.

A discussion of the applicable cost of capital to the Navy in Chapter III indicated that the approximate 5 per cent interest cost of debt to the Federal Government was a good compromise for the cost of capital. Although other means of selecting a cost of capital rate are theoretically available, the computations which would be involved are lengthy, with no assurance that the results would be more useful than the proposed interest cost of 5 per cent. Projects which are not economic cannot be justified by

economic analysis and the cost of capital rate is therefore not applicable in these instances.

What Is the Best Way To Handle Risk or Uncertainty Allowances in the Analysis of Capital Investment Projects in the Navy?

The Department of Defense recommends that a flat 5 per cent discount rate be added to the 5 per cent cost of capital as a risk allowance in the analysis of most economic projects. In the paper, it was contended that the 5 per cent addition to the required discount rate was a poor method of risk allowance, and that risk could be better handled by manipulation of the project input factors.

The project which was selected for analysis demonstrated the differences in the two approaches to risk. Analysis of the project using Defense criteria resulted in a present value of the benefits which was less than the investment cost; the project returned less than 10 per cent and would have been rejected by Defense. Analysis of the project by the recommended technique showed a 93 per cent probability of exceeding a 6 per cent yield, which compares favorably to the assumed 5 per cent cost of capital. Adoption and use of the recommended criteria would most likely result in project approval.

This paper has emphasized the point that arbitrary establishment of a fixed risk will result in the disapproval of "profitable," worthwhile projects. Until that time when sufficient experience has been gained with

analysis of the Navy economic project, it will be beneficial to handle risk in an individual project basis.

Conclusions

1. The discounted cash flow methods of capital investment analysis provide the best approach for project analysis.

2. The present value technique provides the best means for analyzing mutually exclusive projects.

3. The yield technique provides the best means for analyzing competitive projects.

4. The present value technique is applicable for all project analysis within the Navy, in mutually exclusive situations.

5. The yield technique is applicable for analysis of all economic projects within the Navy, in competitive situations.

6. The discount rate to be used in all applications of discounted cash flow techniques in the Navy should be 5 per cent.

7. The variable input factor provides the best means of accounting for the risk involved with each specific project analysis.

8. The variable input factor technique of risk accountability is best handled with computer assistance, but by making reasonable assumptions, the factors can be manually manipulated in a reasonable time and produce meaningful results.

9. Establishment of a separate economic project section within the Military Construction Program would produce two beneficial results: It would provide justification for, and the ranking of, economic projects; and it would mean that projects not classified as economic would have to be justified on other criteria. Although the latter benefit is somewhat negative, it is also positive in the sense that non-economic projects could then be viewed more rationally on the basis of requirement alone rather than the presently possible mix of pseudo-economic plus requirement basis. This sole improvement by itself would be a worthwhile contribution to the capital investment review process of the Navy.

APPENDIX I

EXTRACTS FROM INTERIM OPERATING PROCEDURE No. 6

ECONOMIC ANALYSIS OF PROPOSED DEFENSE INVESTMENTS

ASSISTANT SECRETARY OF DEFENSE
Washington, D.C. 20301

Comptroller

25 Aug 1966

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
DIRECTOR OF DEFENSE RESEARCH & ENGINEERI
ASSISTANT SECRETARIES OF DEFENSE
ASSISTANTS TO THE SECRETARY OF DEFENSE
DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: Interim Operating Procedure No. 6 - Economic Analysis of Proposed Defense Investments

The attached Draft Interim Operating Procedure describes a process of economic analysis for evaluating proposed defense investment projects. It is expected that the Military Departments and Defense Agencies will apply the economic analysis technique described in the enclosed instruction beginning with the presentation of their FY 1968 budget estimates.

Recognizing that we have never systematically applied this kind of economic analysis to the Department of Defense budget, I am making Mr. Arnold Saitow, of my staff, available immediately on a full time basis to discuss this technique with members of your staff, either individually or in groups. He may be contacted directly on Extension 77514.

Your comments on the draft procedure are requested by September 12, 1966.

/s/

Robert N. Anthony
Assistant Secretary of Defense

Enclosure

ASSISTANT SECRETARY OF DEFENSE
Washington, D.C. 20301

Comptroller

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
DIRECTOR OF DEFENSE RESEARCH & ENGINEERING
ASSISTANT SECRETARIES OF DEFENSE
ASSISTANTS TO THE SECRETARY OF DEFENSE
DIRECTORS OF DEFENSE AGENCIES

SUBJECT: Interim Operating Procedure No. 6 - Economic Analysis of Proposed Defense Investments

References: (a) Definition of Expenses and Investment Costs

(b) DoD Instruction 7220.15, "Budgeting and Accounting for the Cost of Military Personnel Services," June 1, 1966.

(c) DoD Instruction 4100.33, "Commercial or Industrial Activities - Operation of," July 22, 1966.

I. PURPOSE

This procedure provides specific instructions for evaluating proposed defense investment projects where the justification for such projects is economic.

II. APPLICABILITY

The provisions of this instruction apply to all Military Departments and Defense Agencies.

III. SCOPE

A. In the evaluation of proposed defense investments the central problem is one of comparing the relative merits of various proposals and selecting those that will be the most beneficial. This instruction provides a framework for analysis which will allow the decision

maker to compare the economic implications of a number of alternative courses of action and assign a priority or ranking to each course of action based on this analysis.

B. For the purpose of this instruction the term "Investment" refers to acquisitions of resources (usually real property and equipment) made in the hope of realizing benefits that are expected to occur over some relatively extended period of time. Investments are proposed and evaluated on a "project" basis. Projects should be so defined that all resource commitments and all benefits related to the life cycle of the project, regardless of timing, are included in the investment proposal. Note that under this concept, all resource commitments and benefits associated with the proposed project are included regardless of the source of the funds. That is, although an investment proposal usually requires Procurement and/or Construction Appropriation funds, it may also require operating funds.

C. Examples of investment proposals are:

1. Repair vs. replace (new procurement).
2. Refurbishment to reduce operating and/or maintenance costs.
3. Fuel conversion to reduce fuel costs.
4. Consolidation projects for warehouse, depot, and repair plants.
5. Modernization projects to mechanize, improve work flow and layout, and increase capacity.
6. Material and supply handling projects to increase efficiency and capacity.

D. Note that each of these situations possesses the essential characteristics for an economic analysis: a commitment of resources with the expectation of receiving benefits (i. e., cost savings) over some future period of time. Further, these resources and their attendant benefits can be measured, to a significant extent, in dollar terms.

IV. DEFINITIONS

As used in this directive, the following definitions will apply:

1. Investment - Reference (a).

2. Expenses - Reference (a).

3. Economic Life - The period of time over which the benefits to be gained from the project may be reasonably expected to accrue to the Department of Defense. (Although economic life is not necessarily the same as physical life or technological life, it is significantly affected by both the obsolescence of the investment itself or the end of the purpose it is designed to achieve.)

4. Benefits - Increases or gains, net of associated costs, in the dollar value of goods and services that result from conditions with the projects, as compared with conditions without the project. For example, for a cost reduction proposal involving the replacement of an old machine tool with a new one, the cost reduction benefits would accrue in the form of reduced maintenance, reduced down-time, greater volume of output from the

same work force, reductions in overtime premium, reduced scrap and defective work, etc.

5. Discount Rate

(a) A discount rate is management's evaluation of two factors associated with Investment Analysis:

(1) The interest cost of the money; and

(2) The risk associated with the proposed project. The rate selected is then used to equate the present value of the benefits expected to the investment required to evaluate whether or not the proposed project is, in fact, justified.

(b) Three rates will be used in the economic analysis of proposed defense investments:

(1) For long-term (10 years or more) noncancellable lease agreements a rate of 5% will be used.

(2) Lease or buy decisions involving lease agreements of 10 years or less with cancellation clauses will be made using a 7% rate.

(3) A rate of 10% will be used in the economic analysis of all other defense investment proposals.

6. Profitability Index - An arithmetic ratio obtained by dividing the present value of the benefits by the Investment for any given project. This ratio is used to rank the various projects under consideration. The higher the Profitability Index, the more

desirable the project in that the benefits received outweigh the costs involved. A project with a Profitability Index of less than 1.0 should not be undertaken unless there are compelling qualitative considerations which outweigh the economics involved.

V. EVALUATION

Although an economic analysis is part of the information that a decision maker should consider, it rarely provides the complete basis for the decision. At one extreme there are alternative choice decisions which can be made almost solely on the basis of an economic analysis. "Lease vs. Buy" and "Replacement Decisions" (replacement of an existing asset with a newer model) fall into this category. Another category of alternative choice decisions involves projects for which the economic implications must be weighed against other qualitative considerations. "Make vs. Buy" decisions involve an economic analysis but also require, for example, a judgment as to whether the proposal is in conflict with the Government's policy of not competing with private industry. Finally, at the other end of the spectrum, there are those projects for which it is difficult or impossible to quantify the associated costs and/or benefits. Examples of these might include projects to comply with local fire, zoning, or sanitary regulations. These differences should be recognized and the weight given to the economic analysis should be governed accordingly.

VI. PREPARATION AND SUBMISSION OF INVESTMENT EVALUATIONS

A. An economic analysis should accompany each proposed project in the Construction and Procurement program/budgets where the primary justification for investment is economic. Only those projects for which funds are requested for the budget year need be so analyzed.

B. The economic analysis will be carried out in accordance with the procedures contained in Enclosure 1. It will be included with the program/budget submission supporting material.

C. The economic analysis will be reviewed by appropriate PAO's and CAO's as will the reasons for the absence of such an analysis. Where necessary, additional information and/or clarification will be requested from the submitting component.

Instructions for Preparation of
DD Forms _____ & _____--Economic Analysis
of Proposed Defense Investments

A. General

1. Differential Costs - The economic analysis is concerned only with differential costs, i. e., the costs and benefits arising directly out of the project in question. Costs or benefits that will occur whether or not this project is undertaken should not be included.

   a. A great many cost items will be unaffected by the alternatives under consideration and these may be disregarded. Attention should be focused upon those cost items that will be different under one alternative from what they will be under other alternatives (including the present situation).

   b. Few specific suggestions can be made as to what costs should be included in an alternative choice calculation because of the diversity of problems encountered. In general, only those costs that would be incurred if the alternative were adopted should be considered. Labor costs are relevant in many problems; but if in a specific situation the same number and types of people are going to be employed regardless of which alternative is adopted, labor costs may not be relevant.

2. DD Forms _____ & _____ are to be submitted with all proposed defense investments whose justification is economic. They are to be submitted in 5 copies, unless otherwise requested.

B. Specific Entries (DD Form ____)

1. Submitting DoD component - Self-explanatory

2. Project Title - Self-explanatory

3. Date of Submission - Self-explanatory

4. Description of Project - Describe what is proposed and the essentials of the rationale for the proposal.

5. Investment

a. Investment costs are those usually associated with the acquisition of equipment and real property. They are "one-time" purchases (as opposed to regularly recurring items) and include:

(1) The costs of rehabilitation, modification or addition of land, buildings, machinery and equipment.

(2) The costs of rehabilitation, modification or addition of other capital items such as furnishings and fittings required to put the project on a "ready-to-use" basis.

(3) The costs of rearrangement, tooling and training associated with the project.

(4) The costs of freight, foundations and installations required by the project.

(5) Non-recurring services received from others, both internal to and external to the DoD, when the cost of such services can be measured feasibly and with reasonable accuracy. (Charges for regularly recurring services received from others will be netted against benefits in the year incurred.)

b. Working Capital.

Working capital is the financial representation of those resources on hand or on order. Included are inventories of consumable items and resources required to operate service units (i. e., resources used to obtain and advance service prior to being reimbursed by the responsibility center receiving the service). Only the changes (plus or minus) in working capital requirements necessitated by the project under consideration are to be included in the analysis.

c. Terminal Value of Existing Equipment or Facilities.

In many Defense Investment projects, the proposed purchase of a new piece of equipment or facility obviates the need for an existing piece of equipment or facility. The value of these replaced assets (as measured by sale price or scrap value) will be treated as a reduction in the Investment required.

d. Net Investment

The arithmetic sum of the items included as Investment.

6. Present Value of Benefits - This figure will be taken from DD Form _____, Line H.

7. Profitability Index - A ratio derived by dividing Investment (A) into the present value of Benefits (B).

C. Specific Entries (DD Form _____)

DD Form _____ is a detailed listing of the benefits to be received by the Department of Defense as a result of undertaking this particular project.

The period of time for which these benefits will accrue is a function of the economic life of the project in question. Note that the benefits received in any given year are to be expressed net of any additional cost increases incurred in that same year by the project. Examples of cost increases include: insurance, maintenance, and service costs and other overhead items such as procurement management, contracting offices, audit offices, project offices, etc.

The definitions of the specific items to be used in this analysis are consistent with Reference (c) and are reproduced here for convenience.

1. Personnel

   This category includes the change in personnel costs (civilian and military) including employee benefits that will result from the implementation of the proposed project.

   a. Civilian Personnel Services. Enter on line A1 the cost of civilian personnel services involved directly in the work performed. The cost of civilian personnel paid at annual rates will be gross pay as shown in current pay tables, plus the Government's contribution (which is 8.3% of base pay) for civilian retirement, disability, health, life insurance, and where applicable, social security programs.

      If labor costs are determined on the basis of direct labor hours applied, the civilian pay rate increased by 29.2 percent to include leave and other benefits should be used. The 29.2

percent acceleration of civilian pay represents the average cost of leave (20.9 percent for sick leave taken and for annual, holiday and other paid leave accruals), plus 8.3 percent for average Government contributions for other benefits.

b. Military Personnel Services. Enter on line A2 the cost of military personnel services involved directly in the work performed. This cost will be computed in accordance with instructions contained in Reference (b), plus the established additional factors to cover PCS travel, moving expenses and medical services costs.

c. Other Personnel Costs. Enter on line A3 the sum of personnel costs which pertain to performance of the function under consideration, and which are not included in lines A1 or A2, such as travel, per diem, and moving expenses, living and uniform allowances, initial and recurring costs of personnel training, etc.

2. Operating

This category covers the net savings in operating costs (other than labor) and includes:

a. Materials, Supplies, Utilities, and Other Services. Enter here all the costs to the Government of supplies and materials used in providing a product or service. Include in this figure the cost of base transportation which can be directly identified with the function, costs for handling, storage, custody and protection

of property, and the cost of utility services including specifically electric power, gas, water, and communications related to the function. Initial start up costs for new activities will also be included. Cost of material and supplies will include consideration for reasonable over-runs, spoilage or defective work.

b. Maintenance and Repair. The cost of maintenance and repair to the buildings, structures, grounds and equipment utilized by the function involved in producing the goods or services. Care must be exercised not to include capital improvements. Engineering estimates may be used to compute proper proportions of costs chargeable. Include on this line only those maintenance and repair expenses directly attributable to the project under analysis.

c. Insurance (Property and Employee Liability). Include here the change in insurance costs resulting from uninsured losses, insurance premiums, settlement of loss and damage claims, and the cost of claims. This figure can be approximated by applying a factor of 0.3 percent to the total of the annual savings shown on line D.

3. Overhead Costs

Include here the changes in overhead costs at the installation levels attributable to the project in question. These include finance and accounting, personnel, legal, local procurement, medical services,

receipt, storage and issue of supplies, police, fire and other services. Include also any contract termination, lease cancellation, or other costs which may become due as a result of undertaking the project in question.

4. Present, Proposed, Savings

Within each of the benefit categories, the distinction between "present" and "proposed" is made. The present column seeks to identify the level of costs that would accrue without the project under analysis while the "proposed" column defines the level of costs that would accrue to the Government if the project is undertaken. "Saving" represents the difference between "present" and "proposed" on an annual basis.

It is possible for these cost savings to be different for each year of the economic life. For example, savings can be negative during the first year or two (due to start-up costs) and then become increasingly positive during the middle and later years of the life of the project. Recognition of the timing of the benefits received should be a part of this analysis.

5. Total Annual Savings - The sum of the savings in Personnel, Operating and Other.

6. Economic Life - Enter here the years of economic life.

7. Discount Factor - Select the appropriate discount factor from Present Value Table B in Enclosure 2.

8. Present Value Savings - Multiply Total Annual Savings on line D times the discount rate on line E.

9. Present Value of Terminal Value - This figure represents the terminal value of the proposed project multiplied by the appropriate factor from present value Table A in Enclosure 2.

   Terminal value-proposed project-gives recognition to the fact that at the end of the economic life of the project in question, the physical assets involved may have some remaining value. This value may be the scrap value, or the assets may be used elsewhere in which case the terminal value is their alternative use value. In addition, completion of the proposed project may result in a change in the level of working capital requirements. If so, the amount of this change should also be included as a part of the terminal value.

10. Total Present Value of Above Benefits - Line F and Line G.

11. Explanation of Source/Derivation of Estimates - Include here a narrative description of how the benefits of this project were derived or calculated. This description must not exceed one page.

ECONOMIC EVALUATION - DEFENSE INVESTMENTS

Submitting DoD Component

Project Title

Date of Submission

Description of Project:

A.	Investment (Itemize)	$ Amount
	1.	
	2.	
	3.	
	4.	
	5.	
	6. Working Capital Changes	(+ or -) _____
	7. Less Terminal Value Existing Facilities	_____
	8. Net Investment	$
B.	Present Value of Benefits (From Form ____)	_____
C.	Profitability Index (B ÷ A)	_____

DD Form _____

ECONOMIC EVALUATION - DEFENSE INVESTMENTS

DETAIL OF BENEFITS

		Present	Proposed	Annual Saving $
A.	Personnel			
	1. civilian			
	2. Military			
	3. other			
B.	Operating (Itemize)			
	1.			
	2.			
	3.			
	4.			
	5.			
C.	Other (Itemize)			
	1.			
	2.			
	3.			

D. Total Annual Savings $_____

E. Economic Life: ____ years Discount Factor _____

F. Present Value Savings $_____

G. Plus Present Value of Terminal Value $_____

H. Total Present Value of Above Benefits $_____

DD Form _____

ECONOMIC EVALUATION - DEFENSE INVESTMENTS

DETAIL OF BENEFITS (CONTINUED)

I. Explanation of Source/Derivation of Estimates

Name and Title of Principal Action Officer Date

DD Form _____

APPENDIX II

BUDGET ESTIMATE OF PROJECT P-406

PUBLIC WORKS AND SHIPS DIVISION FACILITIES,

SECOND INCREMENT

U.S. NAVAL STATION, ADAK, ALASKA

1. DATE	2. FISCAL YEAR	MILITARY CONSTRUCTION LINE ITEM DATA	3. DEPARTMENT	4. INSTALLATION
1 OCT 1966	1968		NAVY	NAVAL STATION

5. PROPOSED AUTHORIZATION	6. PRIOR AUTHORIZATION	7. CATEGORY CODE NUMBER	8. PROGRAM ELEMENT NUMBER	9. STATE/COUNTRY
$ 1,400,000	P.L. -	219.10	2 38 03 86 2	ADAK, ALASKA

10. PROPOSED APPROPRIATION	11. BUDGET ACCOUNT NUMBER	12. LINE ITEM NUMBERS	13. LINE ITEM TITLE
$ 1,400,000	-	P-406	PUBLIC WORKS AND SHIPS DIVISION FACILITIES, 2ND INCREMENT

SECTION A - DESCRIPTION OF LINE ITEM

14. TYPE OF CONSTRUCTION		PHYSICAL CHARACTERISTICS OF PRIMARY FACILITY			
a. PERMANENT	X	a. NO. OF BLDGS. 4	b. NO. OF STORIES -	c. LENGTH VARIES	d. WIDTH VARIES
b. SEMI-PERMANENT	X	e. DESIGN CAPACITY -		f. GROSS AREA 51,838 SF	
c. TEMPORARY		g. COOLING -	CAP. -	COST ($ -)	

15. TYPE OF WORK	
a. NEW FACILITY	X
b. ADDITION	
c. ALTERATION	
d. CONVERSION	X
e. OTHER (Specify)	
16. REPLACEMENT	X
17. TYPE OF DESIGN	
a. STANDARD DESIGN	X
b. SPECIAL DESIGN	
c. DRAWING NO. -	PRE-ENG

19. DESCRIPTION OF WORK TO BE DONE

Conversion of portion of warehouse building No. T-1441 to provide for relocation of PW Department functions including:

Sheet metal, motor rewind, electric, pipe and plumbing, saw and key, sign, refinish, paint, carpentry, upholstery, office equipment repair, and furniture and appliance repair shops

Operations, maintenance and design offices

Central tool room, staging area, training room, vault, conference room, lobby, reception, laboratories, mail room, blueprint room, toilets, and storage

(Continued on DD Form 1391c)

SECTION B - COST ESTIMATES

20. PRIMARY FACILITY	U/M	QUANTITY	UNIT COST	COST ($000)
PUBLIC WORKS DEPARTMENT FACILITIES	SF	43,560	$ 23.16	$ 1,009
SHIPS DIVISION FACILITIES	SF	5,800	$27.24	$ 158
REFUELING VEHICLE MAINTENANCE FACILITY	SF	1,890	$56.60	$ 107
MOTOR POOL FILLING STATION	SF	588	$61.20	$ 36
21. SUPPORTING FACILITIES				$ 90
PIER 3 IMPROVEMENTS	LS	-	-	14
DEMOLITION	LS	-	-	76
22. TOTAL LINE ITEM COST				$ 1,400

SECTION C - BASIS OF REQUIREMENT

23. QUANTITATIVE DATA (U/M SQUARE FEET)		
a. TOTAL REQUIREMENT	83,038	
b. EXISTING SUBSTANDARD	202,543	
c. EXISTING ADEQUATE	0	
d. FUNDED, NOT IN INVENTORY	31,200	
e. ADEQUATE ASSETS (c + d)	31,200	
	AUTHORIZED	FUNDED
f. UNFUNDED PRIOR AUTHORIZATION	0	
g. INCLUDED IN FY 1968 PROGRAM	51,838	51,838
h. DEFICIENCY (a - e - f - g)	0	

24. RELATED LINE ITEMS -

25. REQUIREMENT FOR LINE ITEM

The Public Works Department and Ships Division of NS, Adak occupy 202,543 SF in 22 scattered, deteriorated, makeshift wooden structures and Quonset Huts, constructed during World War II. By consolidation of warehouse operations, 2 large warehouses are available to provide space for the Public Works Department and Ships Division. This move will eliminate $1,677,000 in repair project costs and reduce annual cost for building maintenance, labor, utilities, and vehicle maintenance by $147,420. All of the 22 buildings should be demolished since continued use of them is not feasible. The cost to repair these buildings exceeds 75% of the cost of replacing them through this relocation. The first increment of this item in the FY 1967 MCON Program provided for the relocation of transportation functions at this Station. This second increment will complete the relocation by replacement of other existing Public Works and Ships Division activities, thus allowing for the demolition of the 22 existing substandard structures and saving in repair and operation costs. Aside from the savings to be gained, the severe climatic conditions (high winds, average annual precipitation of 61" of rain and 90" of snow, and a mean temperature of 36° F) dictate consolidation of facilities into a compact, efficient industrial area. Morale also would be greatly enhanced by removing unsightly buildings from an already bleak environment and providing more habitable facilities in which to work. Unless provided, the objectives of this relocation initiated by the first increment cannot be realized.

1. DATE	2. FISCAL YEAR	MILITARY CONSTRUCTION LINE ITEM DATA (Continued)	3. DEPARTMENT	4. INSTALLATION
1 OCT 1966	1968		NAVY	NAVAL STATION, ADAK, ALASKA
5. LINE ITEM NUMBER		6. LINE ITEM TITLE		
P-406		PUBLIC WORKS AND SHIPS DIVISION FACILITIES, 2ND INCREMENT		

ITEM 19 - DESCRIPTION OF WORK TO BE DONE: (CONT'D)

Conversion of portion of Warehouse Building No. T-1443 to provide for relocation of Ships Division functions including:
Engine repair and overhaul, ships repair, and rigging shops
Decompression chamber, compressor, and storage tank
Offices, toilets, storage room, battery room, generator room, and mechanical equipment room

Pier 3 improvements including:
Construction of 2 new 10' X 15' access platforms
Extension of electrical distribution and telephone systems

Construction of Refueling Vehicle Maintenance Facility:
Concrete foundations, frame, floor, walls, and roof
Outdoor concrete purging apron
Total building area includes space for vehicle wash and steam cleaning, vehicle repair, toilet, and mechanical equipment room

Construction of Motor Pool Filling Station:
Concrete foundations, frame, floor, and walls
Built-up roofing on insulated metal deck extended to cover concrete service apron
Total building area includes space for office, oil storage, and air compressor and tank

Demolition of PW Department Buildings No. D-839, T-1436, T-1460, T-1470, T-1471, T-1474, T-1475, T-1502, T-1504, T-1510, T-1544, T-2776, V-17, V-25, V-71, V-200 and V-201, and Ships Division Buildings No. T-1416, T-1418, T-1421, T-1426 and T-1433

Fallout shelter excluded - cost exceed 1% limitation

APPENDIX III

CORRESPONDENCE BETWEEN NAVAL FACILITIES ENGINEERING COMMAND AND THE NORTHWEST DIVISION OF THE NAVAL FACILITIES ENGINEERING COMMAND

05C/JEW:lm

28 Dec. '66

From: Commander, Naval Facilities Engineering Command
To: Commanding Officer, Northwest Division, Naval Facilities Engineering Command

Subj: Economic Justification of Project P-406, Public Works and Ships Division Facilities, 1st and 2nd Increment

Encl: (1) Format for economic justification
(2) Proposed OSD draft instruction

1. It is expected that in the near future OSD will issue a new instruction (enclosure (2)) on present value analysis for investment projects, the primary justification for which is an economic one.

2. Accordingly, subject project is being chosen as a test case representing this approach with the expectation that it will be used as an example for other similarly justified projects in the future.

3. It is requested the Commanding Officer, Northwest Division, Naval Facilities Engineering Command coordinate the compilation of the information requested in enclosure (1) with CO NavSta Adak and return it to this HQ, copy to AirSysCom, by 1 February.

J. E. WASHBURN
By direction

Copy to: (w/encls)
CO NAVSTA ADAK
AIRSYSCOM

Prepared by: Cdr J. E. Washburn
05C- 74135
lm - 12/28/66

ECONOMIC JUSTIFICATION OF PROJECT P-406, ADAK, ALASKA - PUBLIC WORKS AND SHIPS DIVISION FACILITIES

I. NEEDED INFORMATION.

A. Investment Costs

1. MCON Budget Construction Costs
   a. 1st Increment $_____
   b. 2nd Increment $_____
      (Demolition Cost in a. $_____)
      (Demolition Cost in b. $_____)

2. Working Capital Changes
   a. Cash $_____
   b. Inventory $_____
   c. Other $_____

3. Terminal Value of Existing Facilities $_____

B. Benefits (Life Expectancy: Lowest ___ (yrs) Most Probable ___ (yrs) Highest ___ (yrs))

	Present	Proposed		
		Lowest	Most Probable	Highest
1. Personnel				
a. Civilian	$_____	$_____	$_____	$_____
b. Military	$_____	$_____	$_____	$_____
c. Other	$_____	$_____	$_____	$_____
2. Operating				
a. Material Handling	$_____	$_____	$_____	$_____
b. Maintenance	$_____	$_____	$_____	$_____
c. Transportation	$_____	$_____	$_____	$_____
d. Utilities	$_____	$_____	$_____	$_____
3. Other				
a. M&R Projects	$_____	$_____	$_____	$_____
b. Overhead	$_____	$_____	$_____	$_____

II. EXPLANATION OF NEEDED INFORMATION.

A. 1.a. &b. The total Budget Cost of each increment of the project (break out, in addition, the estimated demolition costs associated with each increment).

A. 2.a. In this consolidation are there any Imprest or other cash fund reductions possible? (probably none) (NAVSTA COMPTROLLER)

A. 2.b. As a result of consolidation can inventories be reduced, and if so, what is the most probable reduction for the life of the project, by years. Additionally, what is the lowest and highest inventory reduction per year. For example:

	FY-1969	FY-1970	FY-1971 Etc.
Lowest	$ 50,000	$ 55,000	$ 55,000
Most Probable	65,000	70,000	70,000
Highest	100,000	125,000	125,000

(NAVSTA COMPTROLLER)

A. 2.c. Other. Any other working capital reductions (or OP, N) reductions. For example, fewer installed shop equipment items as a result of the consolidation. (NAVSTA PWO & SHIPS DIV OFF)

A. 3. Terminal Value. Will all the existing facilities now serving the function be demolished? Or will some be retained for some other use? In case of the latter, what is the most probable value of the retained facility?

B. Benefits: Fill in lowest, most probable, and highest life expectancy of this type construction.

Note: General for all Benefits:

What are the lowest, most probable, and highest value of benefits upon completion of both increments of construction in all the following "proposed" columns?

B. 1.-3. Back up the Present and proposed columnar entries with explanation of Source/derivation of Estimates.

DEPARTMENT OF THE NAVY

NORTHWEST DIVISION
Naval Facilities Engineering Command
1638 W. Lawton Way
Seattle, Washington 98119

ATwater 3-5200
Ext. 384

In reply refer to:
03:MGH:ch
Ser 03/19

1 Feb. 1967

From: Commanding Officer, Northwest Division, Naval Facilities Engineering Command
To: Commander, Naval Facilities Engineering Command

Subj: Economic Justification of Projects P-405 and P-406, Public Works and Ships Division Facilities, First and Second Increments, at the U.S. Naval Station, Adak, Alaska; information concerning

Ref: (a) NAVFAC ltr 05C/JEW:lm of 28 Dec. 1966

Encl: (1) Information for Economic Justification
(2) Explanation of Economic Justification Information

1. Information concerning the economic justification of Projects P-405 and P-406 at the U. S. Naval Station, Adak, Alaska, was requested by reference (a).

2. Accordingly, the necessary information has been obtained from the Commanding Officer, NAVSTA, Adak, and is forwarded as enclosures (1) and (2).

/s/ E. M. Saunders
E. M. SAUNDERS
Acting

Copy to:
NAVAIRSYSCOM
NAVSTA Adak

ECONOMIC JUSTIFICATION OF PROJECTS P-405 AND P-406, ADAK, ALASKA - PUBLIC WORKS AND SHIPS DIVISION FACILITIES.

I. NEEDED INFORMATION

A. Investment Costs

1. MCON Budget Construction Costs
   - a. First Increment: $ 850,000
   - b. Second Increment: $1,422,500
   - (Demolition Cost in a. $ 0)
   - (Demolition Cost in b. $76,100)

2. Working Capital Changes
   - a. Cash: $ 0
   - b. Inventory: $ 1,200
   - c. Other: $ 68,700

3. Terminal Value of Existing Facilities: $ 0

B. Benefits (Life Expectancy: Lowest 18 yrs Most Probable 20 yrs Highest 25 yrs)

	Present	Proposed Lowest	Proposed Most Probable	Proposed Highest
1. Personnel				
a. Civilian	$ 844,692	$	$755,432	$
b. Military	$ 729,484	$	$729,484	$
c. Other	$ N.A.	$	$ N.A.	$
2. Operating				
a. Material Handling	$ N.A.	$	$ N.A.	$
b. Maintenance	$ 28,200	$	$ 55,340	$
c. Transportation	$ N.A.	$	$ N.A.	$
d. Utilities	$ 36,300	$	$ 7,800	$
3. Other				
a. M&R Projects	$1,677,400	$	$ 0	$
b. Overhead	$ N.A.	$	$ N.A.	$

EXPLANATION OF ECONOMIC JUSTIFICATION INFORMATION
(Paragraphs correspond to those of enclosure (1))

I. NEEDED INFORMATION.

A. Investment Costs

1. The MCON Budget Construction Costs as taken from the latest DD Form 1391 are as shown. Demolition of all presently used buildings is called for in the Second Increment.

2. Working Capital Changes

a. There is no change to any cash fund.

b. A slight reduction of inventory will result when shops that are now duplicated are deleted after consolidation. Examples are the deletion of a welding shop in the Transportation Building and the reduction of shops in Ships Division.

c. A reduction of 60 per cent of area now used by Public Works and Ships Division will cause the reduction of shop equipment, i. e., one of two 20-foot lathes will be deleted.

3. The terminal value of existing facilities will be zero since all buildings are proposed to be destroyed.

B. Benefits

1. Personnel benefits will be gained from this project due to better working conditions such as improved heating and lighting, better located shops and better equipment layout within the shops. An estimated six and one half man years will be made available for other tasks resulting from this consolidation. The figure shown is an average wage for a journeyman with a 29. 2 per cent acceleration to include leave, travel and Government-paid benefits.

2. Operating

a. Material handling benefits created by consolidation will be due to shop proximity and are reflected by manpower savings included in paragraph B. 1.

b. Maintenance benefits are derived from savings in the annual maintenance of 22 buildings presently in use and the utility distribution systems in and to them. Maintenance benefits will also be realized by the

Transportation Division through the use of interior space for pool vehicles which will greatly extend the life of the vehicle and reduce the maintenance costs and efforts. Savings will be realized in specific items such as repainting, body work, deterioration of tires, batteries, mufflers, wiring, and other engine accessories. It is noted that the amount in the "Proposed" column exceeds that of the "Present" column. Present maintenance of existing buildings is restricted to break-down service only.

c. Transportation is not involved due to the proximity of old buildings which allows foot traffic between shops and offices. Foot traffic will also suffice for the new facilities.

d. Utility operations will benefit by the deletion of buildings presently in use. Savings will be realized from fuel reduction and plant operation for both heat and power. The abandonment of deteriorated sections of the water distribution system will greatly reduce leakage.

3. Other

a. Nineteen of the twenty-two buildings to be demolished have major repairs required to make them structurally adequate or otherwise usable. The fiture submitted was taken from analysis for past projects and has increased 10 to 20 per cent due to increased scope and annual construction cost increases.

b. Overhead cost according to reference (a) is in this case probably negligible. Some contribution to benefits that were included under paragraph B. 1 will be realized.

[illegible]

c. Reconstruction [illegible] buildings which [illegible]. [illegible] will also suffice for the new [illegible].

d. Utility operations will benefit by [illegible] presently in use. [illegible]. The [illegible] lines of the water distribution system will provide [illegible].

f. Other

a. Relocation of the twenty-two buildings [illegible] increased [illegible] per cent [illegible] cost increases.

b. Overhead cost according to reference (a) is [illegible] probably negligible. Some contribution to benefit that will [illegible] paragraph 8. [illegible] be realized.

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